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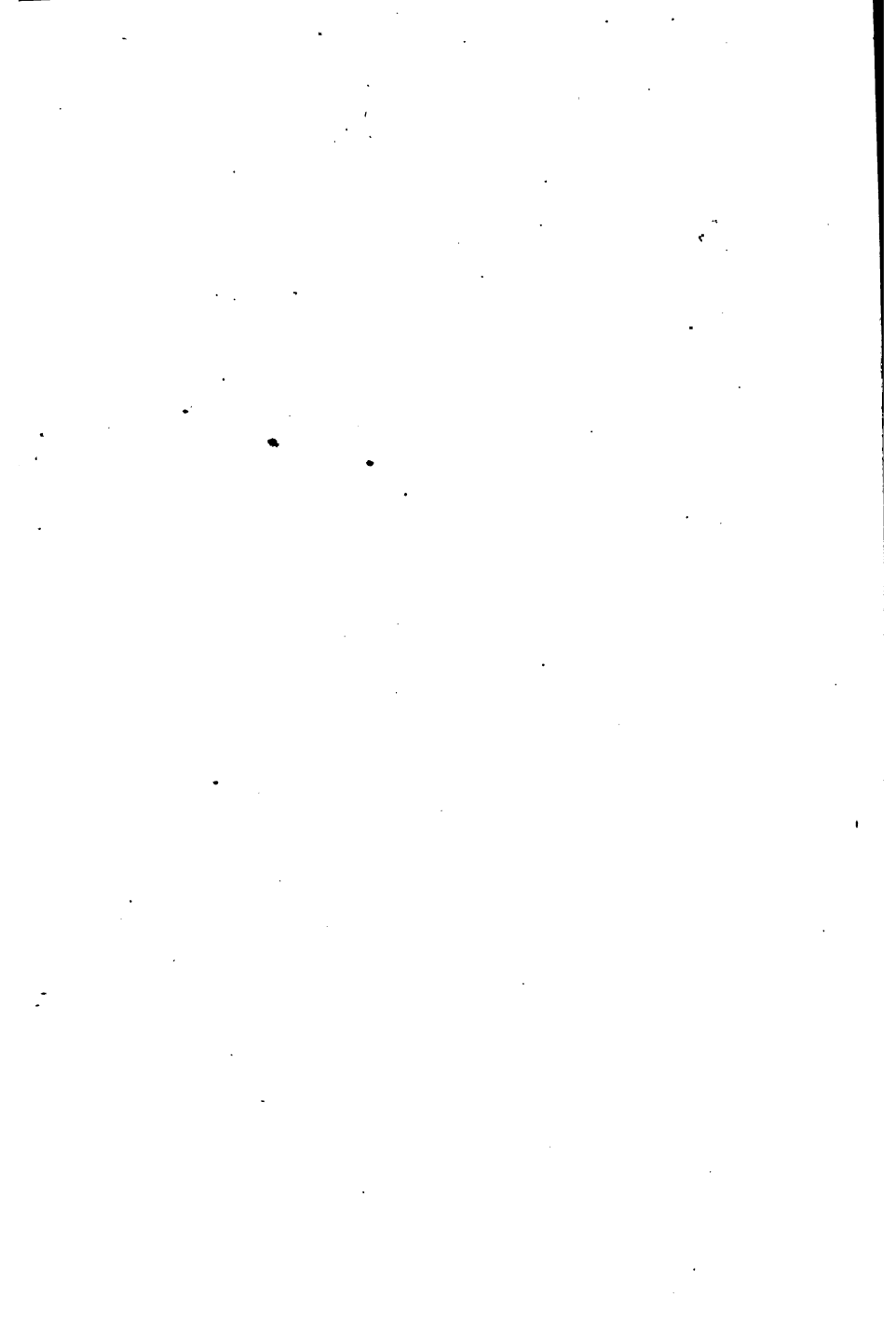
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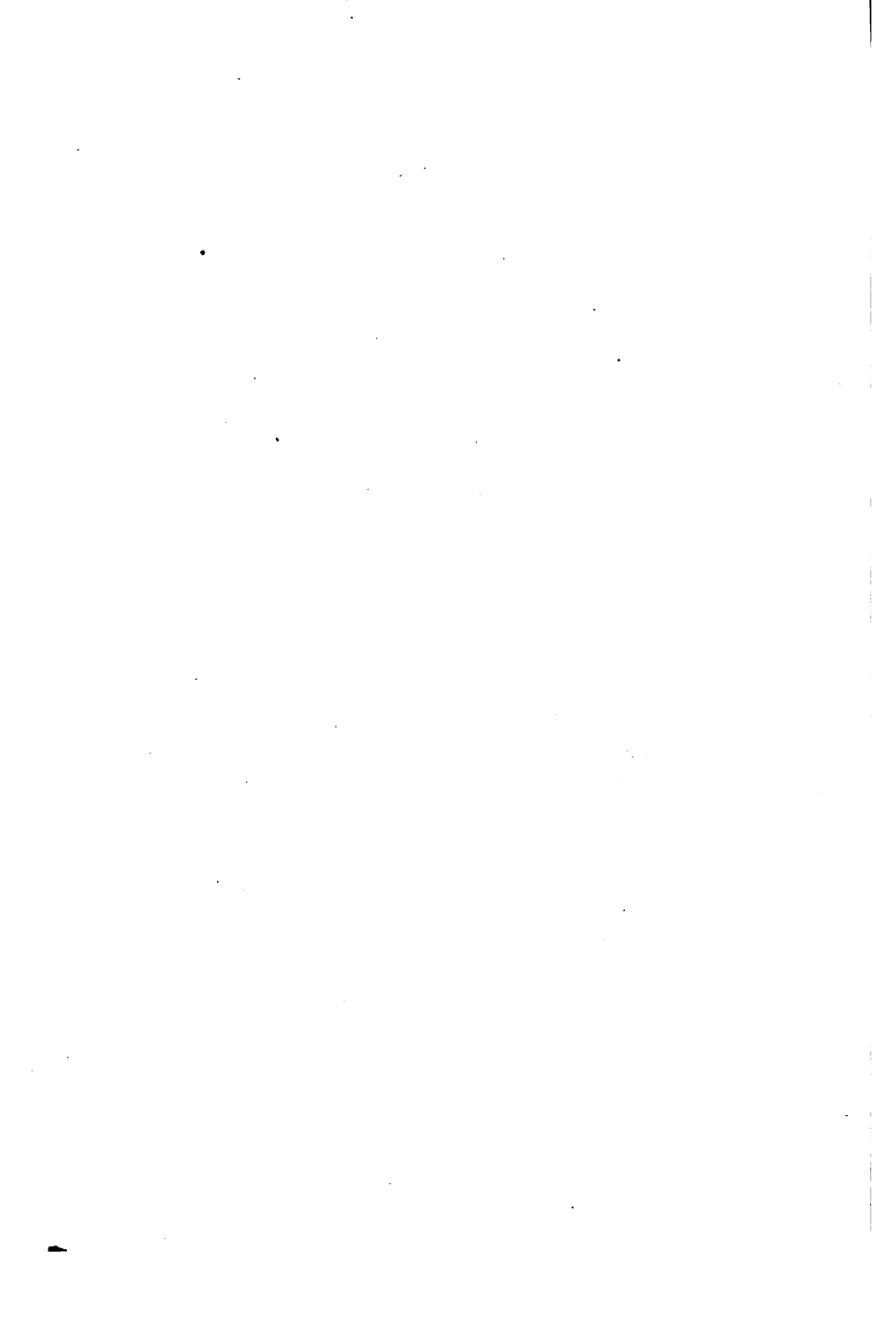
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ARID AGRICULTURE

A Hand-Book for the Western Farmer
and Stockman

BY

B. C. BUFFUM, M. S.

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Former Professor of Agriculture in the University of Wyoming and
the Colorado Agricultural College, and Director of the
Wyoming Agricultural Experiment Station.

*Oh, dear me, no!
It wouldn't be such very hard work to think,
If we did not have to talk or weep or use up bottles of
ink,
Or put to practice in the field
The things our thinkers have revealed.*



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1909

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GENERAL

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1909.

*This book is dedicated to my father, who brought me to the
Mountain Region at a tender age—who was father and
mother to his boys, cook, discoverer, philosopher—
who developed an irrigated stock ranch from the
native wild—who fought and conquered all the
hardships of the pioneer—who, though an in-
valid, gave no thought for himself, but put
forth untold effort to supply me with
every educational advantage the
West afforded at the time.
Such men the country
will never cease
to honor.*





Foreword.

The purpose of this volume is to furnish plain facts in a plain way about the practice of agriculture in the ARID REGION. Whatever its shortcomings, the reading matter here presented is new and original. It has been carved out of a quarter century of experience, observation and study in the dry parts of the West. No attempt has been made to compile scientific data or write a cyclopædia. We have tried to present enough of the practice and underlying principles of arid farming to enable any intelligent man to "make good" on a Western farm.

We feel that this book will, in a measure, meet a "crying need of the hour." The West is now rapidly settling up with new farmers and new stockmen whose measure of success is proportional to the quick and reliable information they are able to obtain. Books on agriculture written from the view point of the farmer or scientist in the humid East, generally are good books, but they do not supply the arid farmer with the most important facts. In the present book we try to give some idea of soil tillage and crop production in the Arid Region. Our admiration is great for the men who are unselfishly helping to solve Western farm and ranch problems, and we invite kindly criticism of the fol-

lowing pages, that we may make them better and more useful.

We gratefully acknowledge personal encouragement and help from many friends. Mr. H. T. Nowell has supplied much of the data for chapters 7 and 8, in Part III. Dr. G. H. Glover has given information in the chapters on Animal Diseases, Farm Surgery and Poisonous Plants. Information, suggestions or help have been furnished by Frank Beach, F. W. Wherren, J. T. Burns, W. Paddock, C. P. Gillette, W. P. Headen, F. C. Alford, L. G. Carpenter and others.

Finally, this book would have been impossible but for the personal friendship of Dr. V. T. Cooke. His deep and accurate knowledge of Dry Farming and the West and his unlimited faith, untiring energy and unquestioned sincerity, have supplied the right ear-mark of the dry farming discussions.

We are already assured of a kindly reception to our Arid Agriculture.

B. C. BUFFUM.

Worland, Wyo., Jan. 15, 1909.

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Part I.

Introduction.

THE ARID WEST.

*Our fathers wrought to till the land
By clearing off the forest grand.
The land was poor,—they planted shad
With every seed to make corn glad,
Taking their cue of what to do
From savage men they overthrew.
And never could they understand
That the Arid West is the promised land.*



Plate I. Some Arid Land Recently Opened for Settlement—Shoshone Reservation.

Photo by Stimson.



CHAPTER I.

THE ARID REGION.

It has again taken forty years of wandering in the wilderness before entering into the fuller possession of our promised land.

ARID AGRICULTURE DEFINED

Arid agriculture is the agriculture of the arid region. An arid country is one in which there is a small amount of rainfall. The word rainfall as here used means the total precipitation during the year, including rain, snow, sleet, and hail. A "small amount of rainfall" means an amount which *used to be considered* insufficient for the raising of field crops without the artificial application of water. The line between possible farming by natural rainfall and impossible farming with natural moisture was formerly somewhat definitely fixed. More than twenty-five inches of precipitation in a year was considered sufficient for the production of general crops. In places where between twenty-five inches of rain and fifteen inches occurs *farming was considered uncertain*, so regions receiving this amount of moisture were classed as sub-humid, or semi-arid.

PROGRESS STEP BY STEP

In parts of the country where the total rainfall is less than fifteen inches there is comparatively little natural vegetation. Early statesmen named the whole region the "Great American

Desert." Stockmen early learned the value of the West for grazing great flocks and herds. With the accumulation of wealth from the public domain they generously dropped the word "desert," and called it the "Short grass country." The storage of mountain snows supplies perennial streams with water which man puts into use for irrigation. A rather persistent belief prevailed for some years that farm crops could not be raised without irrigation. This idea, along with the dry climate and characteristic, unleached virgin soils placed the country on the map as the arid region. Evolution always leads towards greater perfection. Men of broad vision realize that what was impossible yesterday becomes the common possession of tomorrow. These so-called visionaries believed that there were great sections of this arid region in which the soils could and would be made to produce more food and raiment for mankind by artificial means and the application of scientific principles. In the semi-arid region where first attempts at farming generally failed, the pointing of the way by accumulation of experience and the adoption of better methods, has resulted in the establishment of thousands of new self-supporting homes. In the far West, on the Pacific Coast, and here and there east of the Rocky Mountains, farm crops have been produced for more than forty years, in some places with an annual rainfall as small as eight inches.

**COMING OF
MORE
INTENSIVE
DEVELOP-
MENT**

This comparatively new art of agriculture is that of dry farming. A few practical scientists and farmers have been unselfishly studying and demonstrating the possibilities of extending our productive area by the more intelligent use of natural resources. Because some unscrupulous "get-rich-quick" land agents have taken advantage of the movement and exaggerated its possibilities is no reason for condemnation. On the other hand, the feelings of those who have either experienced or known of the first disasters which resulted from settlement, and attempts to follow out the farm methods of our fathers (which had been practiced for centuries in humid regions), must be respected. Nor must we judge harshly the honest skepticism, contempt, or resulting despair of Western stockmen who have spent the best portion of their lives in building up remunerative stock-grazing industries based upon the free use of the range, and whose business is being destroyed by the encroachment of the small irrigation farmer and the dry farmer. It is only right that these men should be well paid for giving up their holdings to new settlement. They have pioneered and braved early hardships, such that only the most hardy could endure. They have builded homes; they have wrested sustenance from the breast of nature and have come to love the occupation which they have made successful only through a lifetime of heart-interests and undivided thought. With no confidence in

the success of the new dry farm movement, the old residents simply see the wrecking of their own industry to no permanent good. They reluctantly admit successes in farming which they did not at first believe possible, but lay the success to temporary favorable seasons. "The handwriting is on the wall." The application of new knowledge, in soil culture, in adapting of useful drouth resistant plants, in machinery and power, and in an hundred significant ways means that there will be no turning backward. The development may come more slowly than the more enthusiastic advocates predict; but come it must, and the gain will be of enormous import to the commonwealths situated in the great arid region—"the best half of the United States."

**EFFECT OF
SOLVING
WESTERN
PROBLEMS**

Agriculture in the West is new. Forty years is a short time in which to develop a new agricultural country. It is true that our earliest great civilizations were all built up in arid regions, but for the past twenty centuries or more (of dark ages) man has taken haphazard chances with humid farming. Although the time has been so short, already some new principles are being worked out which will be found useful to farmer and stockman wherever located. The practice of irrigation is spreading to more humid sections of the country. The principles of scientific soil culture, the conservation and use of moisture,

the relation of the growing season and the crop, the effect of soil aeration, the making available of plant food, the acclimatization and adaptation of plants, the causes of variations, *the value of heredity and pedigree in plants*, as well as in animals, and a host of other farm problems, are being elucidated and solved through necessity in the building up of arid agriculture. Our lessons, in so far as they teach how and why, are useful to all.

**MUST
UNLEARN
THE OLD AND
LEARN THE
NEW**

To meet with greatest success the Eastern farmer who comes West must *unlearn* what he knows about farming. The Western farmer must learn farming anew. The new settler would make fewer mistakes if he could leave behind, with the dust of the farm which he shakes from his feet, the memories of his old farm practices. Many of the first farmers in the West, and especially those who attempt to dry farm, do not succeed. It takes time to learn a new business or the conditions of a new country. It took fifteen years for the farmers of Idaho, Washington and Oregon to learn how to produce wheat with their present success. It took as long for the farmers of Colorado to learn potato culture. As many more years were consumed in working out high altitude agriculture and the use of alfalfa and field peas in these locations. Even now, after forty years of successful dry farming in parts of the West, there are those

in other places who have not seen the work demonstrated, that look upon any claims for success as false. Heretofore every man has had to go through the period of learning for himself. Now he may take advantage of the pioneer's experience and is able to find out the new method in a much shorter time. The important point is that to succeed he must learn and adopt new methods. Successful irrigation or successful dry farming require method, require system, require a shaking off of old conceptions and old traditions and the obtaining of a new knowledge of the relationships of water, soil, climate, crop, and market. Dame Nature of the West holds out most alluring charms, and those who woo and win her smile reap a reward beyond compare. The one thing most needed is correct and accurate information. A few pioneers and scientists have given years of study to these particular problems and have worked out methods which secure the best results. It is the attempt of the writer of this book to present in brief form the more important data of arid farming.

**GREAT
DIFFERENCE
BETWEEN
HUMID AND
ARID
CONDITIONS**

The West is a strange land, even to her own people. Every new achievement in farming brings as sincere expressions of surprise and wonder to our own citizens as they do to the "stranger within our gates." The average tradition and hereditary memory is that of humid climates. The difference between the mountain

region of arid America and the more humid East is so great that it can neither be impressed upon the mind nor fully appreciated in a single generation. We have now learned some of the more important changes brought about by aridity. The small rainfall results in its particular kind of climate and soil. These in turn not only change the entire aspect of landscape and distance, but also profoundly influence the structural life and health of animals and plants and place new conditions into human ethics and the social fabric. The use of open ranges for common grazing ground made men cognizant of each other's rights—the use of limited water-supply for irrigation, at least in all larger systems, enforces co-operation. Lofty mountains, grand distances, and sparse settlement stimulate more individual movement. Stockmen go to market with their product. The people travel. They get their own kind of education from more leisure, more moving from place to place, and more intimate acquaintance with nature and their fellows. They find greater independence of thought and action necessary because, in the struggle for existence, they must overcome unusual obstacles and old forms, and old laws are in many instances not applicable to the change of conditions. The institutions of the West are being founded upon new principles.

Those who attempt to follow agricultural pursuits find crop failure less common, and with

new knowledge the business of farming is more dependable. These things point out a few of the more important differences between the humid and the arid region. With experience, ranchmen and farmers are learning new and important facts which help them to gain success. The lands are being rapidly settled, and in a few years none will be left idle which can be used for crop production. New dry farmers should be made to understand the necessity of following *right methods* in order to avoid failure or delay in securing that independence which they seek.

SYSTEMS OF FARMING

Every farm system known is being practiced in the West. The earliest agricultural occupation was the mere grazing of live stock on the open range. This was rapidly followed by the combined use of ranch and range. With this raising of live stock at home instead of shipping in feeders, came rapid development in the quality of stock through giving them better care, the raising of winter feed, and greater attention to breeding. With the development of irrigation there came into existence some pure farming where the field crops produced were the entire dependence of the grower. At the present time we have a large class of dry farmers who are practicing both pure farming and the combined raising of stock and crops. Truck gardening and fruit growing are also practiced. We have

named the combination of irrigation and dry farming "supplemental farming."

FARMING AREAS

In the best watered states of the arid region it is estimated that from five to ten per cent. of the total area may ultimately be reclaimed by irrigation. Approximately twenty per cent. of the area is covered with mountains and forests. According to our present knowledge, between twenty per cent. and thirty per cent. may be cultivated by so-called dry farm methods, leaving some fifty per cent. of the total area as grazing, mineral, and waste land. There are considerable areas still remaining which are subject to entry under the land laws of the United States. In Wyoming alone there are some forty-eight million acres open to entry, or over seventy-five per cent. of the total area. It should be pointed out, however, that practically all the land which is easy to reclaim by irrigation is now in private control. There are still large opportunities to develop reservoirs and reclaim new lands, and considerable areas are yet to come into private ownership, both for irrigation farming and range uses. The agricultural resources of the West are only beginning to be developed. *The surface has hardly been scratched*, but such a beginning has already been made that the wonder and astonishment of the world has been attracted by the agricultural displays made at state fairs and the great international expositions.

**ROOM FOR
MORE PEOPLE**

The West is filled with paradoxes. The word arid is sometimes used to mean poor, or unproductive. However, there are no lands in the world more productive than our best arid lands, unless we except the soils forming the deltas of some great rivers. The most thickly populated delta lands support over five hundred persons per square mile, or about five-sixths of a person for each acre.

Some Western lands have been made to support four cows per acre. If they were ordinarily good cows and gave twenty pounds of milk per day apiece, five-sixths of a person could not drink the milk. If the forty quarts of milk per day from the four cows were sold for five cents a quart, the income of two dollars ought to give entire support to a whole man. With such possibilities the comparatively small irrigated portion of arid America would support a population equal to one-half the total present population of the United States. The arid region can also supply two-hundred-acre dry farms to a half million farmers and give each one as much more land for pasturage or range. With the average sized farm family this makes room for two millions more population in this land of promise. Time and the future will make the promise good.

**CLIMATE OF
THE DRY
COUNTRY**

This arid region we are writing about has from one-sixth to one-half the amount of rain and snow which comes in other parts of the

United States. The air is dry, rarified, cool, free from poisonous gases and germs, invigorating and generally moving. There are few cloudy days. The sun shines over sixty per cent. of his time on the people. In New York state, for comparison, the glorious sun shows his face only sixteen per cent. of his time, and the quality of the shine is stingy at that. Disease germs are things of darkness and dampness. Dry sunshine is the most deadly thing to disease germs known in the world.

Thermometers for recording temperatures in the arid country are always at work. The temperature is not stationary, but changes more each twenty-four hours than it does anywhere else. Dry air neither burns nor scalds, and it does not carry sultry heat into shady places nor into the night. The nights are cool even where the climate is subtropical. There is no sunstroke or prostration with heat. Farm animals are comparatively free from disease. Such climate carries with it health, comfort and happiness to the people. If a tubercular patient does not get well in this climate, there is some reason that he does not other than the presence of the disease germ.

The arid region covers a large section of the earth's surface. The dry climate varies from the subtropical in the South and West to the frigid of the mountain top. The tops of the higher mountains should not be classed as arid,

however, for they reach so high in the atmosphere that they catch as much precipitation in a year as falls in humid sections.

Over much of the region, especially on the higher plateaus and over portions of the Pacific Slope, there is much wind; while other portions are comparatively free from strong winds. The wind seldom blows hard enough to be destructive, and tornadoes are unknown throughout the mountain regions. Hail and thunder storms are common over a goodly portion of the western prairies and plateaus, and in some sections the farmer should consider the possibility of hail when he selects his principal crops, planting those which will be the least injured. The climate is marked by great freedom from those storms which prove destructive to life and property in other countries.

**THE
GROWING
SEASON**

The length of season free from frost varies from no frost during the year to places with frost every month. Profitable farming may be done where light frosts may occur at any time during the growing months. In middle latitudes where the altitude reaches 7,000 feet to 8,000 feet the light frosts of summer are practically harmless to short season crops. The grains and grasses, alfalfa and potatoes, beets and turnips, Canadian field peas and other crops will stand several degrees of frost in the spring. Young seedling plants are not injured by an amount of

freezing which totally destroys the same plants at the end of the season. Technically the growing season runs through almost the entire year, even where the winter is severe. Winter grains and the native grasses undoubtedly extend their root systems after the crops are frozen dormant and the tops make considerable growth during warm days, even if the nights are very cold. It is important to plant crops early enough so those subject to frost injury will mature before early frosts come. Spring grains and tender vegetables are in this class. How advantage may be taken of the growing season depends upon the character of crop grown and the particular climatic conditions of each region.

**RAINFALL OF
THE ARID
REGION**

The total precipitation is less than fifteen inches per year. The character of the precipitation and the time it comes varies greatly. In the region west of the Rocky Mountains the larger part of the moisture falls in the winter months and the summers are dry. East of the Rockies as much as seventy-five per cent. of the total moisture falls in the spring months when it is most useful for the germinating seed and the early growth of plants. Where irrigation is depended upon it is important to store a part of the flood waters and the run-off from early melting of mountain snows into reservoirs for the supply of late water when the streams are low. The dry farmer, where winter rains prevail,

stores the moisture in his cultivated ground and the fallow lands of other regions act as storage until there is sufficient for the maturing of crops.

THE ARID REGION RAINFALL TABLE.

STATE	PLACE.	Sec. of State.	Winter Inches	Spring Inches	Summer Inches	Fall Inches	Totals Inches
CALIFORNIA	Los Angeles	S. W.	8.9	4.3	0.1	2.3	15.6
	San Diego	S.	5.4	2.4	0.3	1.3	9.4
	Salton	S.	1.6	0.3	0.3	0.3	2.5
OREGON	San Jose	E. Cen.	7.5	4.6	0.1	2.6	14.8
	The Dalles	N. Cen.	7.8	2.6	0.9	4.1	15.4
	Pendleton	N. E.	4.7	4.2	1.8	3.8	14.5
WASHINGTON	North Yakima	E.	4.0	2.0	0.7	2.2	8.9
	Spokane	East	6.8	4.1	2.7	4.7	18.3
	Carson City	West	5.3	2.7	0.7	2.1	10.8
NEVADA	Potts	Central	2.0	3.1	1.4	0.8	7.3
	Pioche	S. E.	4.3	2.8	...	1.6	11.2
	Roise	Central	5.2	3.7	1.3	2.7	12.9
IDAHO	Pocatello	S. E.	3.0	4.1	0.9	1.8	9.8
	Provo City	Central	3.9	3.9	0.9	2.2	10.9
	Moab	Eastern	2.0	1.8	1.4	2.3	7.5
UTAH	Salt Lake City	N. Cen.	4.1	5.9	2.0	3.8	15.8
	Logan	N. W.	3.4	5.8	1.5	3.4	14.1
	Kalispell	North	3.4	4.1	4.3	4.6	16.4
MONTANA	Crow Agency	South	1.9	4.3	4.8	2.6	13.6
	Laramie	South	0.9	3.5	3.5	2.0	9.9
	Frankston	S. W.	4.0	4.3	1.9	2.9	13.1
WYOMING	Cheyenne	S. E.	1.3	4.7	5.0	2.1	13.1
	Ft. Laramie	E. Cen.	1.4	4.3	3.7	1.7	11.1
	Rawlins	S. Cen.	2.9	4.6	2.8	2.6	12.9

STATE.	PLACE.	Sec. of State.	Winter inches	Spring inches	Summer inches	Fall inches	Totals inches
WYOMING	Lusk	E. Cen.	1.5	5.1	4.7	1.6	12.9
	Alcova	Central	1.5	3.6	2.5	1.8	9.4
	Lander	Central	1.9	6.3	2.6	2.6	13.4
	Thayne	W. Cen.	4.3	4.0	2.7	3.3	14.3
	Buffalo	N. Cen.	1.4	4.2	3.9	1.6	11.1
	Basin	N. W.	1.4	2.1	1.2	0.6	5.3
	Four Bear	N. W.	0.9	4.1	3.8	2.5	11.3
COLORADO	Ft. Collins	North	1.6	5.8	4.6	2.6	14.6
	Denver	Central	1.7	5.4	4.4	2.2	13.7
	Grand Junction	S. W.	1.4	2.2	1.9	2.2	7.7
	Las Animas	S. E.	1.0	3.6	5.1	1.7	11.4
	Hams	On Divide	1.0	4.8	6.1	1.2	13.1
NEBRASKA	Kimball	W.	1.9	5.3	5.9	1.8	14.9
KANSAS	Garden City	S. W.	2.4	5.6	8.6	3.0	19.6
NEW MEXICO	Santa Fe	N. Cen.	2.0	2.7	6.2	3.3	14.2
	Mesilla Park	S. Cen.	1.2	1.0	4.8	2.4	9.4
ARIZONA	Prescott	Central	4.5	2.8	5.3	3.0	15.6
	Tucson	S. E.	2.3	0.9	4.5	2.1	9.8
	Yuma	S. W.	1.3	0.4	0.4	0.6	2.7

a—Largest rainfall in winter.

b—Evenly distributed.

c—Spring and summer receive most moisture.

d—Late summer.

e—Spring and summer.

f—Summer.

**THE
RAINFALL
TABLE**

The figures given in our rainfall table have been carefully selected from Bulletin "Q" of the U. S. Department of Agriculture. The places at which observations have been taken are representative of the different sections of the arid region. The season when the most moisture comes has much effect on the agriculture, especially if dry farming is practiced. As the total amount is given for each season of the year, any one can see at a glance when the most moisture falls. On the western slope and in the Great Basin the principal precipitation occurs in the winter months. In northern Montana it is quite evenly distributed through the year. In Colorado, it varies, being generally heavier in the spring months. Attention is called to the fact that on the Divide South of Denver, considerable precipitation comes in late summer and the farmers produce good potato crops which require late moisture, without practicing special dry farming methods. The table is especially interesting to the dry farmer and no attempt has been made to show the relation of this rainfall to irrigation further than its general effect on crops in addition to the use of running water and that from storage reservoirs.

ARID SOILS.

Three kinds of soil are seldom, if ever, found in the arid region. These are peat or muck soils, sour or acid soils and leached out soils. The soils vary greatly, but whether sandy or

clay, they are similar in several particulars. They are rich in lime. They have all the minerals contained in the rocks from which they came and sometimes more, because of accumulation of soluble salts. They are poor in humus, or vegetable mold.

Doctor Hilgard states that the soils over a larger part of the arid region have never been wet to a depth of two feet. With light rainfall, there is no percolation of water through the soil to carry out soluble parts. When the compacted surface soil is broken up, aerated and put in absorbing condition, it catches the rains and snows and the lower soil which was before dry, becomes saturated with the moisture which would otherwise flow off the surface or be evaporated from the upper layer.

Soils in arid regions are much richer in soluble alkalis, salts and mineral plant foods than are the soils of humid sections. Where the rainfall is heavy, these salts have been washed into the drainage. They have become a part of the salt of the sea and are lost to agriculture. Some of the minerals are essential plant foods, others, soda and magnesia, seem to stimulate plant growth. Still others, as lime, have a marked effect on the character and condition of the soil.

It has been shown that the humus in arid regions contains an average of about three times as much nitrogen as the humus of eastern soils. Although our soils are poor in humus, they are

not so poor in nitrogen as the lack of humus would indicate. But it is in looseness or flocculation and mineral elements that our western soils excel. Of the salts of sodium and magnesium, we have an abundance and some to spare. Excessive accumulation of these salts through over irrigation and lack of management causes the waste spots of some farms where the land has been taken with alkali.

Of the more important minerals, as potash and phosphoric acid, the most of our soils contain enough for a long series of years of cropping. An average of thirty-four analyses of soils from Colorado, Wyoming and California, taken consecutively, though somewhat at random from the reports, gives approximately 40,075 pounds of potash and 6,970 pounds of phosphoric acid per acre in the surface soils, given in Roberts' "Fertility of the Land," all but one of which are from the East and South, gives 17,599 pounds potash and 3,936 pounds of phosphoric acid per acre in the surface soil. This shows over two and one-fourth times as much potash and one and three-fourth times as much phosphoric acid in the arid soils which have been studied. The manner in which these minerals become available and are used by the growing crops is another question.

tural practice, suited to their particular needs. The soil culture and crop treatment required to give the best and most remunerative returns in the West are not given elsewhere in any available form. The dry farmers who would produce crops with a minimum amount of soil moisture must follow a definite method. The irrigation farmer or stock ranchman can meet with greater success through knowledge of new scientific facts relating to his occupation, and the dry farmer, wherever located, will find it useful if not indispensable to him to know the advanced methods worked out for his special conditions.

Part II.

DRY FARMING.

*With faltering steps the pioneer
Who could not see the future clear
Here pitched his tent. With flock and herd
He garnered wealth from forage stored.
'Rose murmurs when some spying men
Brought from the land the fruit, for then
'Twas shown that in this barren soil
There is wealth in truth to be gained thru toil.*





Plate II. Wyoming State Dry Farm Demonstration, East of Cheyenne—1908.
Winter Rye, 44 Bushels Per Acre; Winter Wheat, 35 Bushels Per Acre.
Photo by Stimson.

CHAPTER II.

DRY FARMING.

Pessimism about our possibilities of development is sometimes fostered by selfish interests, but men are often mistaken about what is best for them.

THE TERM
"DRY FARM-
ING" AS GOOD
AS ANY

The term "Dry farming" is often objected to because it states an untruth. No crop can be produced without moisture. Dry farming means farming where the annual precipitation has not been considered sufficient for the production of profitable crops. Indeed, dry farming is usually carried on where the rainfall of one season is not sufficient and the moisture must be saved up for a longer period.

Perhaps dry farming is as good a combination as can be invented to specify this kind of agriculture. At any rate, no other term has been suggested which covers the practice and is not more objectionable. To designate it as *Scientific farming is not good*, for farming is an art. Science is as useful, if not as indispensable, to other forms of agriculture. Scientific farming has been used also to designate the semi-arid cropping along the border of the region of sufficient rainfall. Arid farming is a most excellent term, but it has a broader meaning. As here used arid agriculture covers the whole subject of production from the soil in the states where aridity prevails.

**DRY FARM-
ING AN OLD
PRACTICE**

The raising of crops without irrigation in a dry country is *not new*.

In some parts of our own country, farmers have been self-supporting on farms which receive less than fifteen inches of rainfall per year, *for almost a half century*. The general introduction of dry farming to all sections of the west is a new movement. Men of little faith, with much prejudice and less information, have raised their voices in most vigorous protest wherever the new system has been introduced. Some of this opposition is righteous indignation over the exaggerations of dry farm enthusiasts and land agents. Regardless of such opposition, dry farming has met with such degree of success everywhere that it not only holds its own but is spreading rapidly. Many are quick to claim that the successes are due to excessive moisture, but with the use of the two year conservation method the normal rainfall is *repeatedly proven sufficient*. It is now safe to predict that the system has come to stay and that a considerable portion of our range land will be made to produce more profitable crops than it does in native grass. Many stockmen are wisely trying cropping on a small scale. It is undoubtedly true that many new settlers who think they already "*know all about farming*" are destined to fail, but the few will learn how and practice well what they learn. Unless in unsuitable locations, these men will stick. There are enough favor-

able locations and it is safe to say that the art of dry farming is permanently established.

**THE KEY TO
DRY
FARMING**

The key to dry farming is the conservation of moisture and making it available to the growing crop. All the operations of soil culture and plant cultivation are carried out with the object of storing moisture in the soil and making use, through the crop, of all that can be saved. The tillage which is carried out to perfect the use of the water supply does other things which increase fertility and favor the growth and maturing of plants.

**DRY FARM
METHOD AND
SYSTEM**

The principle then, upon which dry farming depends for its success is the catching, storing and saving of enough moisture in the soil, to secure a crop. The method by which this is done includes some special attention to all the factors of tillage, as plowing, planting, harrowing and cultivating. So the dry farmer must possess and use advanced information of principles and practice. The system which is generally carried out is to conserve two years moisture for one crop. By this system one-half of the land is cropped each year, while the other half is summer tilled. In favorable seasons, or by the use of certain combinations, it is often possible to obtain two crops in three seasons. No doubt there are drouth resistant crops which can be made to produce, every year, in favorable locations. After

a crop is removed from the soil and the land is again put in condition to absorb all the moisture that comes, should there be heavy rains, it may be put into winter grain or again planted to spring crops the following season. The soil culture and crop treatment followed must be carried out at the right time and in the right way to insure the greatest success.

SIZE OF DRY FARMS

One man with a small amount of extra help should be able to farm at least 160 acres by the summer tillage system. How much land can be used to advantage depends on the kind of farming, knowing how to take advantage of conditions, having the proper equipment and other things. We have two opposite conditions in the arid region. The small farm unit is most profitable for pure farming under irrigation. The large farm unit is important to the dry farmer. Every man should have double the land he has in crop and at least as much more for stock pasture. A section of land would secure a more certain livelihood than smaller holdings, and half section farms where no water is available for irrigation are as small as should be acquired by the average farmer, over a large section of the dry farm country.

EQUIPMENT FOR DRY FARMING

It does not require any new, complicated or expensive machinery with which to follow out the most successful methods of dry farming.

Ordinary tools may be used, but having them is absolutely necessary. The bricklayer would make a sorry job of laying up a wall without a trowel. No man should attempt to do any kind of farming without proper equipment. The dry farmer ought to have the following list of tools:

Four or six horses.

Three section drag harrow.

A two gang plow, twelve or fourteen inch.

A single walking plow.

A good disc harrow (14 inch disc best).

One or two good cultivators.

An Acme harrow.

Wagon and hayrack.

Mowing machine.

Two sets of harness.

A Press drill.

Potato planter and digger.

Harvesting machine.

An alfalfa harrow.

A weeder.

A float or drag.

The necessary small tools.

MIXED FARMING

The best paying dry farms will be those in which a system of cropping and *feeding stock* is combined. Where the crops are fed to stock on the farm and the manure and waste returned to the land, the loss of soil fertility is so small that we need take no account of it. In fact, while

there is an actual loss of plant food from the soil, so much of the natural stored plant food is made available that the producing power of the soil continually increases. The plant food elements used up when a crop is fed to hogs is only 15 per cent., and when fed to horses, cattle or sheep it is only four or five per cent. of the total. The balance is left in the manure and may be returned to the soil. The manure is a very important item also, to be added to arid soils, as it increases their vegetable mold, making them very retentive of moisture and helping the work of soil bacteria and chemical agents.

We would suggest also that many of the grains raised for stock food may be cut and fed without threshing, which avoids the extra work of threshing and hauling to market. There are great opportunities in the arid region on account of our market facilities, our favorable climate and the natural richness of our stock foods in protein, for the building up of profitable stock feeding industries. The feeding of lambs is already of much importance, and there is hardly a location in which the raising and feeding of hogs, principally of the bacon type, cannot be made highly profitable. Poultry properly managed always give good returns. Many dry farmers also will have the use of more or less adjoining range for the pasturage and partial support of their stock.

**SUITABLE
SOILS**

Not all soils are suitable for dry farming. Unless a soil is sufficiently deep and sufficiently retentive of moisture, or can be made so, to store the water that falls on it from one season to the next, it will not be a good soil for this system of farming. *The soil must be looked upon as a reservoir for water.* If the reservoir is too shallow or too hard the storm water will not soak into it. If it leaks at the bottom or cannot be so protected that too much of the moisture will not be lost by evaporation from the top, attempts to reclaim it will meet with failure. Many of our soils are hard or compact at the surface in their natural state, but may be made to absorb all the moisture that comes by a single plowing. Heavy, compact clay absorbs water slowly, and loses it rapidly by evaporation. Such a soil, especially if underlaid with a shallow hardpan, should be avoided. Sandy loams are the best soils, and the more sandy they are, as a rule, the more retentive they are. They will hold water better if they contain a supply of well decomposed vegetable mold. Such soils two or more feet deep can usually be successfully worked, other conditions being favorable. We believe it no detriment if the soil is underlaid with pure sand or small gravel, unless such sand or gravel contains cement which makes it hardpan.

Sandy soils are kindly soils. They are easy and pleasant to work. They give the farmer time to get around to his necessary tillage opera-

tions. There is little danger of working such soils too wet and practically none of injuring them by puddling when too dry. Heavier soils may do if they contain enough lime so the soil particles are well "*flocculated*." Lime is usually abundant in western soils. Heavy soils may be all right if they contain a sufficient amount of vegetable matter. Dry soils are usually deficient in humus and decomposed vegetable substances.

Flocculation is the collecting together of the very fine particles of soils into bunches or little flocks. An ounce of fine soil may contain over 500 billion particles and if each particle remained by itself, plant roots could not feed in the soil. Lime seems to bring the fine particles together and makes the soil sufficiently granular to be worked. Vegetable mold serves the same purpose, by keeping the soil particles farther apart.

A new farmer who is in doubt about selecting his soil, or what to do for it, should get the advice of some reliable man who has had experience.

**PERSONAL
ELEMENTS
OF SUCCESS**

There are three great personal elements of character not possessed by the unsuccessful farmer. They are, first, the know-how. Second, the do-it-now. Third, the do-things-well. So many let their work crowd them. They do not do so well as they know. There is often un-

avoidable neglect to do important things at the right time. More is generally attempted than can be done. The results arising from lack of these traits in the man, are often laid at the door of natural conditions that are in no wise responsible.

**EXCEPTIONS
TO THE
RULES**

There are exceptions to all rules. Our story of the methods for dry farming practice will need to be modified in detail to meet the particular conditions of each farm. The farmer's ultimate success depends on knowing the principles and then intelligently applying them to his individual problems.



CHAPTER III.

PLOWING.

The plow has evolved from a crude war-club, which was put to use for tilling the soil and afterward became the first letter of the alphabet.

PLOWING

“Stirring and mixing the soil is the fundamental labor of agriculture.” (Roberts.) Plow-



Plate III. Plowing.

ing is the foundation upon which the superstructure of farming is built. It is the matter of first concern to the farmer. Plowing seems to be a simple and easy process, but both the science of the why and the art of the how, are deep subjects. The character of his plowing displays the knowledge of the dry farmer and underlies his success.

DEPTH OF FLOWING

With hardly an exception the recommendation to the dry farmer is to *plow deep*. Ordinarily this means to plow as deep as possible which will generally be from seven to ten inches. This first commandment for dry farming is probably the one most often broken. It is not always possible to plow deep. The soil may be hard. The farmer more often does not have sufficient power to pull his plow. A common condition on western farms is small horses, few of them—and lack of that care which gets the most out of a horse. Sometimes the right kind of plows are not at hand or are not kept in best condition.

WHY FLOW DEEP

The first reason we plow deep is to make a large enough reservoir to absorb and hold the moisture. Our soils have been pounded down for centuries by the patter of rains and the feet of animals. They are too compact and have perhaps never been wet to a depth of more than a few inches. When in tilth some of these soils

will absorb over 40 per cent. of their weight of water. If they contain from 8 per cent. to 20 per cent. of moisture they are in condition to support growing crops. A crop of oats at Laramie did not wilt for some days when the soil contained as little as 3 per cent. of moisture.

**INCREASES
STORAGE
CAPACITY**

How the storage capacity of a soil may be increased by deep plowing may be illustrated by a few figures. A soil weighing one ton per cubic yard, weighs approximately 1613 tons per acre taken one foot deep. If such a soil will absorb and hold 20 per cent. moisture and is plowed six inches deep, it will take up 161.3 tons of moisture per acre. A rainfall of 1.4 inches will supply this amount of moisture and fill up our six inch reservoir. If the ground is plowed only three inches deep, and the sub-soil is hard, it would not be able to store a rainfall of more than seven-tenths of an inch and should more water fall at one time it will be lost and may wash the soil away with it. If plowed nine inches deep and put in good condition, such a soil reservoir would absorb and hold over two inches of rainfall at one time. A soil already containing a considerable water would be filled up with less rain, and deep plowing would be still more important.

**PULVERIZES
AND FINES
THE SOIL**

Deep plowing is usually good plowing in that it grinds up and pulverizes the soil. Soils

that are plowed deep come more rapidly into good tilth. Fining the soil particles releases and makes available plant food. It lets in warmth and air and gives better chance for the activity of chemical agents and bacteria.

**DEEP
FLOWING
GIVES ROOT
PASTURE**

The larger part of soluble plant food becomes available in the surface soil. Plant roots pass thru it easily and here they send out their feeders to make use of the foods ready for them. If four inches of the surface soil is kept stirred for mulch the difference between plowing seven inches deep and eight inches deep equals twenty-five per cent. in the area of the surface soil upon which the roots feed.

**DEEP
FLOWING
SAVES THE
SOIL**

Where the soils are light and winds drift them, shallow plowing may result in all the top soil, down to the sole of the furrow being blown away. Deep plowing on the contrary, throws up heavier and rougher furrows, and tends to anchor the soil in place. Plowing deep, therefore, both prevents washing and drifting.

**WHERE DEEP
FLOWING
MAY NOT DO**

Where soils are heavy, it often happens that only an inch or two of the surface is in condition for the growth of plants. Turning this surface soil under and covering it deeply with cold, untamed and unproductive clay, may prevent raising a good crop for longer time than it is desirable to wait. This seldom occurs in dry farming, for the summer fallow will tend to put the soil

into tilth before the first crop is planted. Some soils may be so shallow that it is not well to plow them deep. Where irrigation is practiced in some of our drier regions where the soil is very poor in vegetable matter, merely discing two or three inches of the surface often gives a better first crop of grain than plowing. Such soils must be irrigated often and carefully because the soil may wash and the area for storage of moisture is so small that it dries out quickly. Generally a soil that is suitable for dry farming is one which may be plowed deeply.

SUB-SOIL FLOWING

Subsoiling is done by using a digger which follows the plow and tears up a few inches of the furrow sole or by means of a mole plow which is run underneath the furrow and lifts and breaks up the subsoil to the depth of fifteen inches or eighteen inches. It is expensive to prepare ground by subsoiling and is not recommended for general practice. Our rainfall is so small that so large a reservoir is not needed for storage of moisture and where irrigation is practiced there seems no advantage from filling so much loose soil with water at one time. There are places where subsoiling is advisable, and it often

- proves profitable for root crops or preparation of land for tree planting.

SECOND FLOWING

The second time the soil is turned, plow about two inches shallower than the first plow-

ing. This is to avoid turning up the undecomposed sod. In our dry climate it ordinarily takes more than one year to incorporate any vegetable matter plowed under, with the soil. Crops plowed under when green, or well rotted manure, will become humus much more rapidly than will dried out materials. Sometimes it is best to back set the land by turning the furrows the same direction as the first plowing. If the land is in good condition, cross-plowing will do more to pulverize and make a good seed bed. It is economy to make the lands as long as possible to avoid much turning at the corners and tramping. If a soil is plowed year after year at the same depth the sole of the furrow becomes packed and hardened by the smoothing action of the plow bottom, and by the tramping of the horses. This may bring good results sometimes where irrigation is practiced, but in dry farming, doing alternate plowings at different depths, tends to break up the furrow sole and allow movement of moisture to and from the subsoil.

**GOOD
FLOWING**

Good plowing is the kind that gives the best results in the crop. What good plowing is, depends on conditions, but the work should be well done. Poor work always leaves its mark and the mark is always a minus sign when its result reaches the pocket book. Good plowing may be defined as the smooth, even furrow so turned that the soil moved, sets more or less on edge with

few and small air spaces underneath, and with the furrow slice crushed and pulverized as much as possible. There should be no skips and the cut and cover method is absent. To do good plowing the furrow should be cut no wider than the plow-share, and to be on the safe side good farmers cut an inch or two narrower than the size of their plows. The plow should be kept sharp and the lays properly shaped. A factor in good plowing is to do the work when the soil is in the right condition. This will differ on every farm. Heavy clay soils must not be plowed too wet. There is little danger of working our more sandy soils when wet. Western soils may be plowed when quite dry and left in condition to absorb the first rains or melting snow. The lime in them insures flocculation and there is little danger of dry puddling.

WHEN TO FLOW

Late fall or early spring plowing is practiced to absorb moisture. In some parts of the West, where the rainfall comes mainly in the winter season, the soils may get so hard and dry that until the rains come it is not possible to plow them in the fall. Where the rainfall comes in the spring and summer the soils are usually in such condition that they may be plowed in the fall, though they are sometimes very dry. A comparatively new practice is to disc the sod or stubble immediately after a crop is harvested to save the moisture and keep the soils in condition

to be fall plowed. The spring season is usually the most busy one and especially is this so at high altitudes where the spring work must be done in a very short time. Having the plowing out of the way by doing it in the fall, enables the farmer to get his crop in early in the spring, and it leaves the soil in the best condition for his seed bed. Small seeds as alfalfa and grains do much better if they are planted on plowed ground that has become fairly compact. Plowing for potatoes or root crops where the soil is compact should be done immediately before the time of planting. Plowing for fall-sown grains, under the two-year fallow system, is better in fall if possible or it may be done in spring or early summer.

**A WORD
ABOUT
PLOW**

The moldboard plow will do better work than the disc. On this account we strongly recommend the use of moldboard plows for first breaking the sod. Disc plows have come to stay, and while they do not do good enough work on sod, they give excellent results for stubble or other old ground, and the draft is easier than with the moldboard plow. The disc is also important to the dry farmer because with it, he may plow soils so dry that the old form of plows could not be made to stay in the ground. The main difficulty with the disc plow is not so much in its use as in its misuse. Nearly every one tries to cut too wide a furrow with their discs, which results in

a sort of cut and cover plowing which will not give the best crops.

No one form of moldboard plow can be recommended for all soils. Where the soil contains much clay or gypsum and lime, we have found the steel moldboard will scour better than a chilled plow. We believe in using a plow with a steel moldboard and with interchangeable lays. The use of cast shares have some advantages. On hard soils they are cheaper. The old share when worn out is thrown away and the new one put on always leaves the plow full width. Every time a steel lay is sharpened it gets smaller, so a fourteen inch plow does not remain fourteen inches.



Plate IV. Plowing Dry Sod Seven Inches Deep.

The steel lays are useful, however, in many soils, and if a farmer has a soil upon which he can use both kinds he can take advantage of all these conditions. A modification of the old sidehill plow is the new two-way plow with which the field may all be turned from one side and avoid extra tramping as well as dead furrows and back furrows.

POWER FLOWING

Where fields are large enough and long lands can be laid out, plowing by steam or gasoline is being adopted in many parts of the West. On our dry prairies at considerable distances from water and coal supply, steam plowing proves ex-



Plate V. Plowing First-Year Stubble Eleven Inches Deep.

pensive. There are new gasoline or kerosene power engines which are coming into much favor for both plowing and other forms of power needed on the farm. A steam engine requires for its running an extra man and team with water tank, and where distances from water and coal are great, this item of expense is a large one. The main difficulty with any kind of power plowing, seems to be lack of knowledge and skill on the part of operators. This kind of work has been eminently successful where men who understand their business can be obtained to do the work.

CHAPTER IV.

THE CONSERVATION OF MOISTURE.

No one should think that dry farming is an attempt to grow plants without moisture. Water is essential, and how to save it for the use of the crop is the greatest discovery of the age.

WATER REQUIRE- MENTS OF PLANTS

There has been much speculation in regard to the possible production of a crop with a certain amount of moisture. This interest has arisen from experiments carried out in France and parts of this country, which show the amount of water taken up by plants and transpired from their leaves to produce their growth. In one of these experiments, it was shown that it took an average of three hundred pounds of water taken from the soil to produce one pound of dry matter. On this basis, Headden made a calculation of the approximate amount of water required for the production of a twenty-five-ton crop of sugar beets. Where sugar beets produce a large amount of tops, these tops have been known to equal at least ninety per cent. of the weight of the roots. To grow twenty-five tons of beets, then, there would be twenty-two and one-half tons of tops. In the beets there would be five tons of dry matter, requiring fifteen hundred tons of water, and the tops and beets together would require 2,175 tons. This amount of water would cover the land to a depth of over nineteen inches, and on

this basis, twelve and one-half tons per acre could be produced with ten inches of moisture, provided it is all saved and made available to the plants.

Several years ago, the author made the following statement: The amount of water found to be necessary to produce one pound of dry crop of grains in the humid region is approximately five hundred pounds, which is used by the plant and evaporated from the soil during growth. An annual rainfall of twelve inches would bring to each acre of land 2,722,500 pounds of water. If all this water could be made available for the crop during the growing season, and assuming that 500 pounds of water is sufficient to produce one pound of dry crop, twelve inches of rain would produce 5,445 pounds, or approximately $2\frac{3}{4}$ tons of vegetable matter. If one-half the rainfall of a single year could be saved to the growing plant, it would support more crop than the average native hay production of our irrigated meadows.

Such speculations are useful as indicating certain possibilities, but it is unquestionably true that some plants require more moisture than others, and there are many things to consider outside of the actual amount of moisture used. There are drouth-resistant crops which will approximately stand still in time of drouth until more moisture renews their growth. Other drouth-resistant crops have so adapted them-

selves to arid conditions that they produce less top and leaf surface to evaporate the water and put their energies chiefly into the production of seed or fruit rather than into the making of much growth. We find nothing in these scientific speculations which is discouraging to the dry farmer or which would indicate that it is impossible to produce profitable crops of suitable plants once in two years where the annual rainfall is as little as eight or ten inches. "The proof of the pudding is in the eating," and such crops having actually been produced under such conditions, is sufficient demonstration of the fact.

Having the principal rainfall come during the growing season is a great advantage in some ways. Often a crop will have used up the stored soil moisture and be ready to give up the struggle when a rain will revive the plants and make them mature successfully. This enables the farmer to take advantage of that useful semi-dormant or waiting character of certain drought-resistant plants.

THE SOIL MULCH

Maintaining the soil mulch is one of the most important factors in the success of dry farming. It is by the soil mulch that we are able to make our soils absorb all the moisture that comes to them by precipitation or from dews or other moisture. By it we conserve this moisture and prevent its loss back into the air by evaporation. Summer-tilled land should at all

times be covered with this mulch, which should be in granular form of small lumps. Care should be taken *not to get it too fine*. Dust does not *absorb moisture* so well and is apt to *drift or blow away*. Working the ground when dry will tend to make the surface soil too fine. The object of cultivating the summer-fallowed soil is to prevent the formation of a crust after heavy rains; to allow proper action of sun and air; to prevent the moisture from rising to the surface where it will evaporate and to *destroy the growth of weeds*. The film moisture in the soil travels up and down by what is called capillary action. This is merely the flowing of the moisture which surrounds one particle of the soil to, and around, the next soil particle, which is close enough to touch the film and so on as long as the soil particles are close enough together, until it reaches the surface where it is evaporated. By stirring the soil, we let in air and separate the grains of soil so the *capillary movement is stopped*, and loss by evaporation is prevented. The soil mulch must be maintained over the whole field, and the drag harrow is the principal tool used for this purpose. Writers have recommended that those who practiced summer-fallowing should get on to the land with the harrow immediately after every rain or snow. This is not always necessary or advisable, for working too soon may cause rapid loss of the moisture which is still in the surface layer. The ground should be worked

as soon after every heavy rain or snow as it is dry enough. Do not wait too long, for when too dry the soil will dust and drift. Light rains may cause actual loss of soil moisture by forming a connection which lifts the water to the surface, where it is lost into the air. Judgment should be used and the ground cultivated as early and often as the conditions indicate.

HUMUS AND VEGETABLE MOLD

There is much misconception about what humus is. Often when we speak of humus, we do not mean true humus, but refer to the partially decayed plant substances, which were better called vegetable mold. True humus is the final product of the decay of organic matter in the soil. It is a very complex chemical compound, which contains nitrogen, and may act in an important way toward the change and use of soil plant foods. On the other hand, it is the partially decayed vegetable matter which has so much to do with tilth. This substance absorbs water, holds the soil particles apart, aerates the soil, and fosters bacterial and chemical changes which are of most value to living plants. This decaying condition must be kept up by continual renewal of organic matter.

PACKING THE SOIL

There are three or more conditions of soil which call for the use of some form of packer. Soils that are covered with so much grass that they do not naturally fall close enough to shut

out large air spaces at bottom of the furrows may be packed to advantage. Loose loam soils that overlie a sub-soil which contains considerable moisture may be packed to bring the particles close enough together to lift the moisture from below by increased capillary action. The surface soil may sometimes be packed to either warm it or get rid of surplus moisture. Where good results follow packing, it should not be neglected for it may mean success. Many Western soils, especially those containing much granite, sand or gypsum and lime naturally become compacted very soon after plowing. *Such soils may be so hard that the attempt to keep them properly loosened up is more important than trying to make them more compact.*

USE OF THE ROLLER

Rolling soil warms it. There are cold, damp soils which may be rolled at times with advantage. It is usually better to use a corrugated roller in the West, because it leaves the surface rough and there is less drying out or drifting by winds. The smooth roller on young grain will sometimes bring up the moisture and cause the soil to absorb enough warmth to prevent injury by cold. The roller is not an essential farm implement on Western farms.

THE SUBSURFACE PACKER

The subsurface packer, recommended for arid soils, consists of a series of wedge-shaped wheels, about eighteen inches in diameter, and

set six inches apart. The object is to pack the lower half of the plowed area and leave the surface loose. This implement is of value on many soils. Its use has not always given valuable results on our more arid soils. There is little advantage to be gained by the use of the subsurface packer over much of the arid region unless it is on spring plowing of sandy soils, because the soil and subsoil is not such that the compacted area either attracts or saves additional moisture, and the ground becomes sufficiently dense for the roots of crops without the additional work. *Packing is often of great value.* Many have observed instances of winter grain in the packed area left by wagon or drill wheels passing over it, living, where adjoining grain was killed out. Generally spring grains produce better growth and crops where some wheel has pressed the soil together.

We believe that packing is always advisable around the newly planted seed and recommend almost *with no exception the use of some form of press drill.* The subsurface packer is better than either the smooth roller, or corrugated roller, unless it is desirable to lose moisture instead of save it, or warming the soil for a time is the end sought. Where the packer is used, the soil should be harrowed immediately afterward to establish the earth mulch.

HARROWING

Next to plowing, the principal operation on the dry farm is persistent and continuous use of the harrow. The ground should always be harrowed the same day it is plowed, and if it is new sod-ground, at least, the harrow should be run the same direction as the plow. This harrowing should be kept up often enough to maintain a proper surface mulch for the prevention of the loss of moisture by evaporation. Small grains should be harrowed in the spring and no damage will be done if the harrow is run crosswise of the drills, the harrow teeth kept sharpened and the horses made to walk fast. The main tools to use for shallow surface cultivation is the drag, or spiked-toothed harrow, and the weeder. Every farmer should have one with levers by which he can regulate the slant of the teeth. It does not pay to use a two-horse harrow on large fields. Four-horse tools of all kinds are far more economical. With a three-section harrow and four horses, a man or boy can cover thirty to thirty-five acres per day, which makes the maintenance of summer tillage possible on a considerable area of farm land.

**THE DISC
HARROW**

The disc is an indispensable farm implement in the West. Discs of fourteen inches diameter do much better and more effective work than do those of larger size. The draft is not so light as is that of sixteen or eighteen-inch discs, but the object of farm operations is to do the work,

and good work cannot be done with a large disc. The disc should be used to break up the surface sod or stubble immediately after harvesting, and where this is done, it will be found that plowing will produce a much better seed bed. Turning under the disced surface also leaves less air space and the soil reservoir is more perfect. The disc is useful to destroy weeds on summer tillage, but it must be used when the weeds are small. It will merely cultivate large weeds. Always lap the disc one-half, which double-discs the ground and leaves it level. The disc is very useful for certain forms of cultivation, especially with alfalfa. The new alfalfa harrow consisting of a series of spikes arranged in disc form seems to be one of the best tools for the cultivation of alfalfa.

OTHER HARROWS

Perhaps the Acme harrow is one of the most useful soil pulverizers for the farm. It does most excellent work where shallow surface cultivation is required. The spring-tooth harrow is a useful implement for harrowing compact and tough soils. There are some new harrows now being constructed on the general plan of the old drag or toothed harrow, but with modified teeth. One is a small disc three or four inches in diameter, riveted horizontally to the lower end of the harrow tooth. Another has the lower end of the harrow tooth bent at right angles and flattened and sharpened in the form of a knife blade.

These harrows serve the double purpose of loosening the soil and cutting off weeds.

**THE
WEEDER**

The weeder is a modified harrow with long curved spring teeth. It is a most valuable implement on dry farms for the easy and rapid cul-



Plate VI. The Weeder in Grain. Photo by McWethy.

tivation of grains and other crops. It can be used after the plants are too high for ordinary harrowing. For large work, using four-horse gang weeders is most economical in time and labor.

**GOOD
HARROWING**

Good harrowing for the purpose of conserving moisture is that which more thoroughly breaks up the surface soil, without making dust

of it, kills the weeds, saves the moisture, and cultivates the crop. If the soil is hard or wet and in such condition that the disc or harrow teeth leave open scratches and cracks instead of mixing and turning the soil, the loss of water will be greater than it would be *without harrowing at all*.

**WHEN AND
WHAT TO
HARROW**

In summer tillage it is not necessary to harrow the ground after every *small rain*, but it *should not be neglected* as soon as the ground is in condition to work after every *heavy rain or melting snow*. There are few crops raised by the dry farmer which might not be vastly improved by harrowing. We do not advise harrowing at all for sugar beets, as the special cultivators are better to use. Corn, or any of the small grains, will be improved by thorough harrowing up to the time they are four or five inches or even more in height. Harrow native meadows and pastures to break them up when sod-bound and aerate these naturally compact soils and to cultivate the grasses. Harrow late in the fall, or winter, or early in the spring, lands infested with grasshoppers or cut-worms or army worms to kill the insects. When you cannot think of any more important work, go to the field and harrow.

CHAPTER V.

CROP MANAGEMENT.

After storing water in the soil or depositing money in the bank, we must draw on it in a practical way.

RESISTANT CROPS

Some of the most resistant crops to drouth are macaroni wheat, kafir corn, sorghum, millet corn, potatoes, alfalfa, brome grass, wheat grass, spelt, beans, winter rye, sainfoin, peas, vetches and Jerusalem artichokes. Crops may be resistant to other things of importance as well as drouth resistant. In parts of the arid region there are streaks where hail storms are more or less frequent. Some plants will withstand the effects of hail much better than others. A heavily bearded grain like Macaroni or Durum wheat or Turkey Red wheat will not be so badly injured by light hail storms as will other kinds of grain. Flax is a good hail-resistant crop and sugar beets will recover after severe hail storms have practically pounded them into the ground.

Farmers are also coming to appreciate more and more disease resistant crops. It seems important that we should produce potatoes resistant to root rot and blight. Some varieties seem more resistant to these diseases than others but the matter has not been fully enough worked out to make definite recommendations. We are working on the leaf-spot disease of alfalfa with hopes

of securing immunity from destruction by this disease.

PLANTING THE CROP

Good seed, good land and good farming require good planting. Special machines for planting are as important as plows or other implements for preparing the ground. Grain sown broad cast or potatoes planted by hand are at the risk of the farmer and at the best can be expected to give only indifferent returns. Grain that is broad casted and harrowed or cultivated to cover, is never well planted. The work is all unevenly done. Some of the seed is covered too deep—some not deep enough—the soil is not packed around the seed—the plants do not have the advantages of light, air and the cultivation they get in the drill rows.

THE PRESS DRILL

The press drill is an essential implement for the dry farmer and will pay for itself in a single season on any average sized farm of the West. It plants the grain evenly, at a proper depth, puts it in contact with moist soil and presses the soil around the seed in a way which secures quick and strong germination of the seed and the best early growth of the seedling plants. A week or ten days is gained in the season by this prompt germination and quick growth. There is a large saving of seed which is an important item. Forty pounds of seed press-drilled is equal to sixty pounds sown broadcast, a saving of 33 per cent.



Plate VII. The Press Drill.

**TIME TO
SOW GRAINS**

Planting fall or winter grains secures advantages to the farmer over sowing spring crops. They have a long season and usually will mature before drouth sets in. Only the winter wheat, winter rye and winter emmer are hardy enough in our northern arid region. Winter oats have been grown as far north as northern Wyoming east of the mountains, but the varieties now used cannot be depended on to produce a crop. Winter barley is being tried but it cannot be recommended as successful yet. Winter rye and Turkey Red wheat give surprisingly good results.

Near Cheyenne these grains stood a winter of unusual drouth, there being only one and one-third inches of precipitation in eight months. After standing this remarkable drouth, winter rye produced 44 bushels and winter wheat 35 bushels per acre. The author is breeding winter emmers for the arid region and these grains give promise of revolutionizing the stock-feeding industry of our western plateaus. Sow winter grains on summer tilled land in September or the first half of October. At lower altitudes on irrigated land some farmers have sown wheat any time up to the hard freezing weather with success. Where fall sown grain can be pastured it may be planted earlier.

Spring sown crops should be planted as early as the ground can be made ready and danger of heavy freezing is over. Catch or volunteer crops sometimes yield enough to be of value from seed that shatters off in the fall.

**SEED PER
ACRE**

Much of the success of dry farming depends on thin seeding. More beginners in dry farming sow too much seed rather than too little. Where grains are sown early and have a correspondingly long season, there is more chance for stooling. For the same reason we should sow larger amounts of seed when we are late doing the work. There may be moisture enough to support ten grain plants per square foot when twenty plants would die of thirst. Limited

moisture therefore calls for thin planting that there may be less danger of "firing" before the crop matures. If the season is well advanced and the soil moist and warm so grains shoot up rapidly they do not take time to stool or make tillers. The reason that some grains are more drouth resistant than others is that they have grown in dry regions so long they have lost the habit of tillering to a large extent and also produce less leafiness to pump moisture from the soil. The following seed table will be found very useful for dry farming. The amounts of seed given are based on the very best condition of seed bed, planting at the right time and with a drill which does the work in the best possible manner. The farmer whose seed bed is in poor tilth or dry, or who plants late or with poor methods, should increase the amounts of seed recommended by from 30 per cent. to 100 per cent.

CROP.	Remarks.	Minimum
		Seed per Acre Pounds.
Alfalfa	For hay, drilled.....	10
Alfalfa	For hay, broadcast.....	25
Alfalfa	For seed in wide rows.....	2
Canada Field Peas.....	(Small)	40
Field Peas	(Large varieties)	50
Sand Vetch .....	.....	20
Millet	Siberian	8
Millet	Common or German.....	5
Proso	Drouth-resisting Broom Corn Millet	6
Brome Grass .....	.....	20
Meadow Fescue .....	.....	20
Western Wheat Grass.....	.....	15
Slender Wheat Grass.....	.....	20
Barley	For threshed grain.....	35
Barley	Beardless for feed.....	50
Oats	For grain	35
Oats	For hay	60
Rye	Winter or Spring.....	30
Winter Wheat	Drilled	30
Durum Spring Wheat.....	Drilled	40
Polish Wheat	For feed	60
Emmer or Spelt.....	For feed	40
Buckwheat .....	.....	20
Flax	For seed	25
Flax	For fibre	50
Broom Corn .....	.....	2
Field Beans	(Small)	20
Corn	In hills and thin.....	4
Corn	In drills	7
Sweet Corn	For fodder	10
Sorghum	For seed	8
Sorghum	For fodder	20
Kafir Corn .....	.....	4
Turnips .....	.....	2
Carrots .....	.....	3
Mangel Wurzel or Stock Beets.....	.....	8
Sugar Beets	To be thinned.....	20

**SOME SEED
SUGGESTIONS**

The best seed, regardless of cost is the most profitable. The cost of good seed is small compared with the value of the resulting crop. The difference in the price of first and second grade seed does not make a great difference in the total cost per acre. Like produces like. The best seed invariably results in the best crop. It is especially important that the dry farmer plant thoroughly clean seed that is free from weeds. We know of nothing that causes greater loss than the presence of worthless weeds. They rob the soil of its moisture and use plant food that belongs to the crop.

Without exception every student of western farming recommends the use of seed that is acclimated or that has been grown under the same conditions as those where they are to be planted, or as near these conditions as is possible to obtain. This subject of the breeding of varieties suitable to our western conditions and the adaptation of plants to soil and climate is one of the most important with which we have to deal. As a rule seeds raised under irrigation or in a humid climate are not good seeds for dry farming. Good seed cannot be produced as cheaply or sold for the same price that common bulk crops bring. With the breeding work that is now inaugurated in the arid region it will be but a few years before new and improved varieties of farm seeds will be made available. This work

cannot fail to make our western farming more successful and profitable.

**CULTIVATING
GRAIN**

The principal implements for cultivating grain are the drag harrow and the weeder. When the grain is too high to be harrowed a weeder may then be used to much advantage. Sometimes the weeder may do the best work from the first. To do the work properly the harrow teeth must be kept sharp and slanted. Good work cannot be done with dull or stubbed-off teeth. Always harrow cross-ways of the drill marks if possible to do so. It often looks as though great injury were being done by harrowing small grain, but it never fails to turn out beneficially. Winter wheat should be harrowed one or more times in the spring and going over twice may be necessary to do effective work. Small grains or even corn may be harrowed until six or seven inches high. The harrow is a good thing to run over the potato field or field peas just when they are coming up.

HARVESTING

Of course the harvest may be carried on by ordinary methods, but the soil should not be neglected at this time. Where our rainfall comes during the summer, discing the stubble after harvesting grain is important. After harvesting potatoes or sugar beets the drag harrow should be used to break up the lumps and re-establish the soil mulch. Barley or other grains that can

be used for feed without threshing should be harvested when in the stiff dough. This prevents, in a measure, re-seeding the ground through the grain shattering out, for in this country practically all the ripe grain which drops on the ground in the fall comes up the next spring as a volun-



Plate VIII. Dr. V. T. Cooke and the Beardless Feeding Barley. Raised by Dry Farming—1908.

teer crop. If the grain can be fed without threshing it is marketed in the best possible way from the farm and saves the cost of threshing and handling.

GRAIN FARMING

Pure grain farming is not the best type of permanent agriculture. On suitable soils, how-

ever, both with and without the summer-fallow system, farmers have practiced grain farming on the same soils for more than thirty years in parts of the West and they have become thrifty and even wealthy doing so. There is no doubt but such soil robbery will result in depletion in time,



Plate IX. The Wyoming State Dry Farm Commission.
Coming Thru the Rye—1908.

Photo by Johnston.

but the extensive grain farmer gives little or no thought to the building up of a productive farm for future generations. He often expects his children to enter the professions or move to some other country for their livelihood. With the practice of growing a single crop year after year,

continued long enough, at the same time adding nothing in plant food, there are few soils upon which, sooner or later, farming will not become unprofitable. Confining the soil to one crop induces the accumulation of insects and plant diseases, which are peculiar to that crop, and when



Plate X. Government Farm, Cheyenne—1908.

the devastation arrives it hits quick and hard. When grain farming is the principle aim in any region, the best practice in addition to the resting of the soil alternate seasons, is to adopt a system of crop rotation which will add fertility.

**ROTATION OF
CROPS FOR
THE DRY
FARMER**

Rotation of crops is not so necessary where land is summer tilled every other year as it is to keep up soil fertility on lands that produce annual crops. However, a regular system of rotation will pay on all dry farms. The principle aim in a rotation for arid lands, is to keep up the supply of available nitrogen. This is done by the use of legumes which, through the action

of the bacteria on their roots, gather nitrogen from the air. Grain, peas or potatoes may be grown as the first crop after breaking the sod. If grain is the principal crop produced, the soil should be improved by raising a crop of peas, beans, vetches or alfalfa. Peas may be grown and plowed under to add vegetable matter. Alfalfa continually enriches the soil in nitrogen and at the same time produces profitable crops where ever the conditions are favorable. Where alfalfa is easily grown it may be plowed up at the end of three, four or five years, but if difficult to get a stand and a good field is secured, the farmer would be reluctant to plow his alfalfa so long as it is giving him good results. It usually begins to deteriorate after seven or eight years. This is due to wrong management. Alfalfa rightly managed, in some parts of the world has stood the test of time not 8 years but 180 years or more. Each farmer must work out his own system of rotation which is applicable to his conditions, but these suggestions will be valuable to him.

FERTILIZING THE SOIL

Arid soils are so rich in mineral elements of fertility which are made available by thorough systems of tillage, that the use of complete fertilizers has not become a question of importance. These soils are generally poor in nitrogen and decaying vegetable matter, and adding these things always brings important increase in yield.

One of the very best methods of adding nitrogen and vegetable matter is green manuring with legumes. Plowing under such green crop puts into the soil a quickly-decaying supply of vegetation and the legumes gather much nitrogen from the air which they make available to other crops. There are some places where the use of nitrate of soda gives good results. A system which enables the farmer to return the crop to the soil in the form of manure cannot be too strongly recommended. Raising a crop of feed which is used by the animals harvesting it themselves in the field, like pasturing to fatten on peas, both returns the manure and spreads it. Where manure accumulates in the feed lot or barn it should always be applied to the land, and a manure spreader is becoming a necessary implement on all modern farms. The sooner manure can be spread on the land after it is made the better the results to soil and crops.

Part III.

IRRIGATION FARMING.

*Here mountain peaks that reach the sky—
Clear rivers that go flowing by.
In "forty-seven" Utah was first
To give soil drink to quench its thirst.
As from the snows the water flows
The deserts must "bloom as the rose."
Science and art go hand in hand
To gladden our hearts and reclaim the land.*





Plate XI. Outlet of Cloud Peak Lake—The Big Horn Mountains—Perennial Water Supply.
Photo by Stimson.

CHAPTER VI.

IRRIGATION FARMING.

The country is dry and the people are the most sober and earnest users of water to be found anywhere.

SIZE OF IRRIGATED FARM

The small boy eats too many green apples just to keep them from going to waste, and the farmer acquires too much land just because he wants the earth. The relation between the size of a farm and its economical working and management has not been given the attention it deserves. Under humid conditions a man could hold much land without feeling any especially baneful effects. Under irrigation the whole problem is changed. In the West, land is abundant, water is scarce; land is cheap, water is expensive. Investments in water rights are too valuable to lie idle. The farmer has less time to do things and get them done in season. Intensive culture characterizes irrigation agriculture. When a crop needs irrigating, the need is urgent. It cannot be put off for the whole crop and the margin of time may be too small to make it profitable to put off farm operations on any part of the field. Maximum returns are only made on small fields, well tilled and irrigated. A farmer may be self-supporting on ten to twenty acres. He finds all he can attend to on forty acres to sixty acres and generally has too much land if he

tries to farm more than eighty acres. This will depend largely on the kind of crop raised. If intensive cropping is done with sugar beets or potatoes in proper rotation the small farm pays best. If the land is all in alfalfa and pasture, larger areas can be managed.

It is safe to say that a great majority of new comers to the West buy at the start from two to ten times as much land and water right as they should.

**PURE AND
MIXED
FARMING**

There are many specialties in irrigation farming. Raising crops for sale is pure farming. This kind of farming requires special knowledge of the subject in order to keep up the soil fertility, and practice culture suitable to the crop produced.

Mixed farming is surer—requires more general and less special knowledge, helps in the economy of living, diversifies the farmer's interests, keeps up soil fertility and makes one thing pay expenses while another may build a bigger bank account. The products from poultry, cows and pigs distribute the money income thru the year, and make it less necessary to borrow money at the bank, at interest, to pay expenses until crops may be sold. Garden and animal products secured with home labor save important items of cash outlay in the household expenses. There may be more or less pasture or range to use which will decrease the expense of keeping stock.

The general farmer will succeed better if he keeps stock and markets his crops on four feet.

**SOIL
CULTURE
FOR
IRRIGATION**

Our soil culture directions for dry farming pertain as well to irrigation, except the summer-fallow, which is unnecessary, with plenty of water to be applied when and where needed. With water and advanced knowledge of how to maintain soil fertility, there is no need of letting any land rest from crop production. Soil culture needs to be given careful and intelligent consideration and special systems are being worked out for the separate intensive crops. Plowing need not be done so deep at first and on some soils shallow plowing may give better results than deep plowing. More attention needs to be given to leveling and smoothing the land where irrigation is practiced. The right kind of land preparation is a permanent improvement which pays from the first because it saves much future expense and trouble. Irrigation farming is a "new agriculture" in the West, and a man needs to know it in order to meet with the success which should crown his efforts. On the same soils and under the same conditions the man who knows how will get fifty bushels of wheat while the one who does not will get twenty-five bushels. Right culture will give one man 300 sacks of potatoes per acre and wrong culture another man 50 sacks per acre. There is a considerable profit to the man who gets 300 sacks of

potatoes if he uses \$40.00 expense per acre to raise the crops, over the man who gets 50 sacks by an expense of \$15.00 per acre. One man nets \$185.00 per acre and the other makes \$22.50 per acre. The man with the large yield probably works only a forty-acre farm, and from twenty acres of it in potatoes banks \$3,700.00 for that crop. The second man is probably trying to farm eighty acres, and from forty acres in potatoes he banks \$900.00. The little farm well tilled has brought its owner over four hundred per cent. the largest net income. The point made is that good tillage for irrigation means thorough tillage and special systems of soil and crop management to produce the best returns.

IRRIGATION AND SOIL FERTILITY

Fertility is measured by the power of soil to produce crops. As we have shown, moisture is an essential element of fertility. Other elements are nitrogen and minerals which are direct plant foods. In much of the irrigated region the waters used contain large amounts of dissolved fertilizing elements. It has been shown that waters which contain much silt carry with them large amounts of dissolved plant foods. Studies of the waters used in irrigation from the Rio Grande River showed that where water was used to the depth of one foot it deposited 955 pounds of potassium, 58 pounds of phosphoric acid, and 53 pounds of nitrogen to each acre. This would be a sufficient supply of nitrogen for

more than thirty bushels of wheat per acre, enough phosphoric acid for thirty bushels per acre, and enough potassium to last for thirty years, if as much wheat was raised on the land each year. Such large amounts of soil fertility are unusual, however, but even our clear waters from mountain streams carry with them a considerable amount of silt and plant food in the late spring and early summer. Under irrigation such large annual crops are taken off the soil that the subject of available plant food becomes an important one. Our soils will wear out unless a good farm practice is inaugurated which will keep them productive. With a proper system of rotation and cropping, adding plant food to the soil in the form of barnyard manure, the waste of feed pens, green manure and growing of leguminous crops will keep the soils always richly productive. Only in special locations or with special crops will the use of any artificial fertilizer be found advisable.

IRRIGATION AND ALKALI

There has been much useless alarm about alkali. Our soils are very rich in soluble salts and in places these accumulate to such an extent that they destroy productiveness. The alkali salts are dissolved by water, and where there is not good drainage below, this water evaporating again from the surface, leaves the alkali behind as a white incrustation where it is most detrimental to plants. In nearly all cases the alkali

accumulation is the result of bad management, generally of over-irrigation or of continuously leaving the water running on the soil. In many parts of the West where the native sod is irrigated for the production of hay, the water is allowed to run for weeks or months over the same land, and such irrigation is apt to produce bad results. Some irrigation waters contain large amounts of alkali salts which are deposited with the water applied.

EFFECTS OF ALKALI

There are two kinds of alkali which are found in different sections of the arid region. In the mountain states where the climate is cool, the white alkali predominates. White alkali is a mixture of the sulphates and chlorides of soda and magnesia. In the warmer regions the alkali is composed of carbonate of soda and is called black alkali. One-tenth of one per cent. of black alkali will prevent the growth of useful plants on the soil, while some crops will stand as much as one per cent. of white alkali salts in the surface soil. These alkali salts in small amount are important aids in the fertility of the land. They make plants grow faster and better than where they are not present. The black alkali destroys the soil tilth, puddling it and making it dark in color. The principal detrimental effect of white alkali seems to be that it retards or prevents the germination of seed. If the salts can be diluted or washed out before planting and

a good stand of plants obtained from the seed, the crop may grow to maturity and make a good yield.

**REMEDIES
FOR ALKALI
SOIL**

The black alkalies of California have been corrected by changing them into white alkali which is less detrimental. This is done by adding considerable quantities of gypsum or land plaster. Land plaster is sulphate of lime. When this comes in contact with carbonate of soda there is a chemical change and the carbonate of soda becomes sulphate of soda, and the sulphate of lime becomes carbonate of lime or common lime stone. The remedy for white alkali is to provide proper drainage and wash the salts out of the soil with irrigation water. The worst alkali soils may be made productive in this way.

**CROPS FOR
ALKALI
SOILS**

There are a few crops which will thrive in the presence of much white alkali. The principal one is the sugar beet. If the salts can be diluted by irrigation before the seed is planted so there is no serious retardation of germination, sugar beets will make good crops on strong alkali soil. Another useful plant to grow in places which would otherwise be waste, is the English or Dwarf Rape for soiling and pasture. One of the best plants to grow in such places either for forage or to improve the soil in vegetable mold is the white sweet clover. There is no need of leaving the alkali places as unproductive and unsightly wastes.

**IRRIGATION
OF FARM
AND GARDEN
CROPS**

Suggestions about the irrigation of different crops will be found in the chapters dealing with culture of these crops in another part of this book and the methods of irrigation for different soils and crops are discussed in chapter 7. Different crops and each kind of soil requires particular treatment and general rules are only of value in so far as they throw light on the underlying principles which may be made use of by the individual farmer who understands them and their application.

**TIME TO
IRRIGATE**

As a broad general statement, we believe the time to irrigate is when there is no crop growing. Nearly all crops should be irrigated before they are planted. The soil should be put in the best possible state of tilth and stored with enough moisture, at least to germinate the seed and supply the early growth of the plants. Potato soil should be irrigated in the spring before it is plowed. Some crops, like potatoes and sugar beets, require the most moisture in the later part of the season. Wheat should be irrigated most during the middle part of the time of its growth. To be on the safe side, barley should be irrigated when quite young. These things show the variation which must be practiced to produce the best results and point to the importance of the farmer looking up the culture for each crop he expects to raise. Some few crops, like onions, should be flood irrigated. Other crops give best results



Plate XII. These Wet Mountain Spring Snows Make Flood Waters for Storage.
Photo by Stimson.

if water is never allowed to touch the crowns of the plant. Some crops should not be irrigated at certain stages of growth unless absolutely necessary to save them. Experience tells the farmer when his crop is suffering for water and no general rule can be laid down. Short season crops may be ripened early by keeping water



Plate XIII. Hanover Canal in Winter.

away. Often late irrigations are responsible for injury to the immature crop by frost.

**WINTER
IRRIGATION**

Over much of the arid region there is possibility of running water on to the soil in the winter season and often sufficient moisture may be stored for the production of most excellent crops the following season. On some farms in the West, even during freezing weather, the water supply from springs or ditches may be run on the land and stored, either as moisture in the soil or as ice on the surface. Using the water in this way in the winter and the same water for irrigating additional land in the summer makes a small water supply cover double the amount of land.

**SEED
PLANTING
FOR
IRRIGATED
CROPS**

Everything the farmer can do to make the application of water to his crop and soil more efficient, should be done. When either flood irrigation or irrigation by furrows is practiced, the crop should be drilled with the slope of the land so the water is more rapidly spread by following the furrows. There is one form of drill that we would recommend irrigation farmers to avoid. This is the single disc drill. The single discs are set opposite ways each side of the center and throw the soil in opposite directions. This makes ridges of soil which interfere with spreading the water in irrigation. In small fields where it is desired to avoid back furrows or dead

furrows the two-way plow will be found of advantage. This implement is a double plow which swings on a pivot and can be changed at the end of each furrow so the land may be plowed from one side to the other without leaving any ridges and with the least amount of turning and tramping of soil by the team. We recommend the use of the four or eight-horse leveler which may be run over the ground both ways after every plowing. Such leveling of the soil saves much work in the distribution of water.

**AMOUNT OF
WATER
REQUIRED**

On new land where the sub-soil is almost invariably dry, much water will be needed the first two seasons to moisten this sub-soil or fill it with the capillary or film moisture, which surrounds the soil particles. Much of this moisture will be held from year to year and it will not be necessary to apply such large amounts in irrigation. The total amount of water to give the best results on different soils and different crops, varies greatly. On light sandy bottom soils with gravel underneath, farmers sometimes use from six to eight feet deep of water during the season. A flood irrigation cannot be made with less than four to six inches at a single application. Usually a thorough flood irrigation will require from nine to eleven inches deep of water over the surface. This does not mean that enough water must run on to the land to stand to this depth, but that the amount soaked into the soil or run

off as waste will total enough to reach the depth indicated if it all remained on the surface. The irrigation laws of the arid states generally provide that the limit of a water right shall be one cubic foot per second continuous flow for from seventy acres to one hundred acres of land. As a general rule, it is thought that enough water to cover the land to a depth of two feet is a sufficient average for Western crops. We are learning more all the time about the economic use of water.

To do effectual irrigating the farmer needs a good sized head of water. A very small stream soaks away too fast and cannot be spread over sufficient land. On land which lies well for irrigation an experienced irrigator can handle a head of from two to three cubic feet per second. If he only has a water right for eighty acres of one cubic foot per second, it usually pays to rotate in the use of water with a neighbor in order to do his irrigating in the quickest and most efficient manner. Many western irrigators use too much water and too little cultivation. Many injure their crops and soils by allowing the water to run too long on one place, drowning the plants and alkalizing the soil. A quick application of water which thoroughly soaks the land and then removing it, to give the soil opportunity to become aerated again, is best.

**DEEP
ROOTING OF
PLANTS**

In the arid region systems of irrigation and cultivation which induce plants to send their roots deep into the soil are important. Deeply rooted plants are not so subject to drouth and find a comparatively large soil pasture from which to gather moisture and plant food. Deep and continuous cultivation from the time the plant is started until the crop has become thoroughly established, will do much to secure deep rooting. This is important in orchards and tree plantations. The cultivation must be continuous, however, for if left for a long enough season of growth most of the plant roots will be thrown into the surface soil, after which cultivation would so severely prune the roots as to set back the growth and injure the plants. Light or superficial irrigation which simply puts enough moisture into the soil to wet the surface induces plants to throw out surface roots instead of those which should go deeper into the sub-soil. It also starts evaporation from the surface which causes loss of water. Deep and thorough irrigation causes deep rooting.

CHAPTER VII.

METHODS OF IRRIGATION.

When it comes to our irrigation practice we are yet in the cut-and-try period of learning how.

GROWTH IN METHODS

The easiest and crudest methods were adopted in the earlier days of irrigation. In sections of India and Egypt, which are thought to be the oldest among irrigated countries, the practice of irrigation has remained almost the same for centuries. Primitive appliances are still in use, such as buckets on sweeps, and other simple animal-power machines for lifting water from the streams or wells to the height of the crop land. In contrast with this is the rapid development of irrigation practice in the Western States. The beginning of irrigation in this country was in 1847, when the Mormons made the great experiment at Salt Lake City little more than a half century ago. Since then development and improvement have been rapid, though many reverses were met with by the pioneers. Now, new methods are proving so superior to the old, that the farmer who would make the most of his land must keep abreast of the times and adopt the more progressive ideas.

LOCAL METHODS

Many localities are characterized by some general method of irrigation. Sometimes this

is a good method for the local conditions and sometimes not. Usually the pioneer has marked out his own system without help. Those who come at a later date take up the local practice and retain it, even though they may see other localities forging ahead of them.

THE IRRIGATOR'S PROBLEM

Crops require water to grow or even to remain alive. The irrigator with a reliable and sufficient water supply has a great advantage over every other agriculturist. He has it within his power to govern the application of water to his fields, to apply it when and where he wishes and in the quantity he thinks best. These advantages bring with them the necessity of learning how to make the most profitable use of the water supply. The problem of the irrigator is to apply water in the right place at the right time, in quantities that will give the best results, and by the most efficient and economical methods. Local conditions and the kind of crop grown should determine the method most applicable. Changes in methods are forced by increase in value of land and water; the intensive system taking the place of the extensive.

WILD FLOODING

This is the natural and primitive method of applying water to crops. In its simplest form it is nothing more than a diversion of the waters of a stream to the land to be irrigated, leaving the laws of nature in charge without further aid

from man. Many native, or wild, hay meadows are irrigated in this way with little supervision other than turning on the water in the Spring and turning it off again a week or so before harvest time. The consequence is usually



Plate XIV. Rock River, with Irrigated Meadows.

Photo by Stimson.

that the meadow is continually under water to a varying depth during the growing season. Only the water-loving or swamp grasses, and the rushes and sedges, survive such treatment. The finer native grasses, as the wheat grasses, are rapidly killed out. As the coarse grasses thrive, and give comparatively good yields, the practice

is in places retained, chiefly among stockmen with only incidental interests in farming and on lands of comparatively small value. As lands increase in value and methods improve, these meadows are re-seeded to finer grasses and more care is used in irrigation. If the practice of wild flooding is retained at all, the meadow is left under water for short periods only, of a few hours to a week in duration.

**FLOODING
FROM FIELD
DITCHES**

This is usually known simply as "flooding," and is perhaps the most widely used of all methods, especially in the newer irrigated districts. The ditches are most commonly run parallel to the slope, irrigation taking place from only one side of the ditch and extending to the next ditch. Sometimes on nearly level land the ditches are run down the steepest slope, irrigation taking place from both sides and extending midway between ditches. Under either method the distance between laterals should not be over 200 feet, and it is better to have them closer together. Irrigation is easier and more uniform if the laterals are only 50 to 100 feet apart, though, of course, it is then necessary to have more field ditches, each one of which takes out some crop-growing area from the field. For valuable crops, however, the advantage lies with the closer spacing of the ditches. These field ditches may be either temporary or semi-permanent. With annual crops, such as grains, the common practice

is to plow and harrow over them, remaking them each year. This is more convenient, as the drills and other farm implements can then be driven across the field without interference by the ditches. It entails the extra work of listing out and trimming the ditches each year. Permanent ditches should also be repaired and trimmed each year, for if this is not done, they are very apt to become irregular, cut out in places, and stopped up with vegetation in other places. The common lister and the V-shaped crowder or "Go-Devil," are the implements commonly used in making field ditches. The "A," or "Go-Devil," is easy to construct, and can be adjusted to make various widths of ditches. In preparing ground for this kind of irrigation it should be brought to a uniform slope by means of scrapers and home-made levellers, or some other levelling device, as the labor of irrigating each year will depend on how well this has been done. This method is in general suitable for medium slopes, soils which do not bake or crust badly after flooding, grains, meadows and hay crops, and for the extensive system of farming, where lands are not of great value, and such crops as require comparatively little attention are raised. While in first outlay the expense necessary is not large, the annual cost for irrigation is usually excessive. From two to five acres a day is as much as one experienced

irrigator can thoroughly water, and as a rule the irrigation is more uneven than with other methods. This causes uneven ripening of the crops, which is, of course, a disadvantage.

**THE
FURROW
METHOD**

There has been a demand for a method of irrigation which does not flood the "crown" of the crop plants, and also one which would not pro-



Plate XV. Furrow Irrigation.

duce baking and cracking of the surface soil, so prevalent with heavy clay soils under the flooding methods. The furrow method accomplishes this. The seepage of water from the side of the small ditch or furrow outward to the crop, or "subbing," is maintained. Various modifica-

tions of the furrow method are used to adapt it to different conditions of soil, crop, or head of water used. For grain drilled in rows eight inches apart it is usual to make the furrows narrow and deep, four to five inches wide, three to four inches deep, and twenty-four to thirty-two inches apart. For alfalfa and other drilled hay crops the practice is much the same; the furrows being perhaps a little larger. The head ditches or laterals between which the furrows are run should not be over 200 feet apart, as a general rule. That is, the furrows should not be so long that the water will not run through from end to end in a reasonable time, say half an hour to an hour. They should be long enough, so the water will have time to "sub," or seep to the side and dampen all the soil between the furrows. The best length will depend on the soil, the slope, the size of, and distance between the furrows. It is determined by the individual farmer for his own conditions without great difficulty.

Root crops are almost always found to do best under the furrow system. Potatoes, especially, show the bad effects of even a break between the furrows, and consequent flooding. In this case the furrows are made quite large, the rows being ridged, and one furrow between each two rows. Sometimes, the best method for the crop and the most economical of water, is to irrigate only alternate furrows, as with sugar

beets and potatoes. The land cultivation, thinning, etc., can then be done from the dry rows more conveniently. The furrow system is coming to be widely used for irrigating orchards.

The method of dividing the irrigation streams between a number of small furrows varies in different localities. At Twin Falls, Idaho, and a number of other progressive irrigation districts, what is called the "lath box" system is used. In this system boxes are made by placing four strips of wood, as common plastering laths cut in half, together and nailing them so as to form a narrow, square-section box which may be used as a pipe to admit water through the lateral bank to the upper end of the furrow. The boxes are placed in the ditch banks at each furrow and are easily closed by a stopper formed of a short piece of lath, or by a small square of tin tacked by one corner over the opening. The most common method in all probability is that of depending on the irrigator to open and close the head of the furrows by means of a shovel and some dirt. Sometimes a flume or trough, or pipe, is used instead of laterals, and holes at proper distances, easily opened or closed, serve to regulate the flow into the furrows. For valuable land, these methods are proving a success, and when the preparation has been completed, the actual labor of irrigation is reduced to supervision of the flow in furrows, and regulation of the little head gates.

**CHECK
METHOD**

This is simply a modified flooding method by which the water is retained at some depth on the land, as long as the irrigator thinks best, instead of being spread out by hand labor while running, as in flooding. This is accomplished by means of small dikes or levees thrown up, either in rectangular, or square form, or along contour lines. The square system makes the fields take on somewhat the appearance of a gigantic checker-board, whence the name given this method. The check system is best suited to land having very little slope. On practically level ground the banks may be placed far apart. In parts of Arizona and New Mexico on such land they may be as much as a half mile apart, thus inclosing a quarter section in a single "check." But in general the "checks" or squares are very much smaller, often containing less than a quarter acre. The higher and stronger the retaining banks are made, the greater the area that can be enclosed in a check. For crops that must be worked with horses and machinery, it is not practical, as a rule, to make the banks over one and one-half to two and one-half feet high, as there is liable to be damage to farm machinery in crossing higher banks. If the side slopes of the banks are made slight, too much area is taken from the land that could otherwise be cropped. This system entails a large first cost and is also subject to the following dis-

advantages: The top soil, usually the best, is removed to form the banks; even after levelling, the checks usually have enough slope so that the water stands considerably deeper on the lower end of check than on the upper, which produces unevenness in the crop, some getting too much and some too little water. Considerable area is withdrawn from cultivation by the levees; it is hard to cross levees with heavy machinery. The great advantage is in the ease of irrigating and the large head of water that may be quickly applied and thoroughly controlled by the irrigator.

The "contour check" method differs from the rectangular only in the way the levees are made. In this system surveys are made of level, or "contour" lines, spaced as far apart as it is practical to control the water when irrigating. This system may be used on steeper slopes than the preceding, in which case the checks are long and narrow and usually somewhat curved in outline, following the natural slope.

**NATURAL
SUB-IRRIGA-
TION**

This is a method that applies only where certain rather unusual conditions exist. These are: First, an impervious hardpan or rock stratum a short distance below the surface and parallel with it. Second, a shallow bed of gravel or coarse sand above this, through which water can seep easily from a ditch at the upper end of the field. Third, a rather fine soil not so deep, but

that the water from the saturated gravel bed below may be drawn up to within a few inches of the surface, and not so shallow as to be unsuited to cultivation or to be kept too moist from the supply below. So many requirements have to be met that the natural conditions for the use of this method are rarely found, and the system is uncommon. But where the conditions are right perhaps no other practice is so advantageous and cheap. The ground does not have to be so accurately graded as in other methods—the irrigation ditches needed are only the main laterals, made deep enough to let the water they contain into the porous bed below—and little labor for irrigation is required. A further advantage is that level, clean culture may be practiced. Nearly all the advantages of the most expensive pipe sub-irrigation system are obtained, and almost without expense. Soils in which sub-soil is filled with free water are not suitable for deep rooted plants like alfalfa.

**SUB-IRRIGATION BY
PIPES**

This is the most expensive and at the same time the most economical of water of all the irrigation methods. It is best, when putting in a system of this kind for orchards or other very valuable crops, to get the services of a competent irrigation engineer. The details of this method are usually complicated and must be worked out for each farm.

**THE BASIN
METHOD**

This is a flooding system used almost exclusively for orchards. It is practiced more in California, perhaps, than in any other State, though it has superseded to a large extent the "check" method, which it very closely resembles. The principal difference between this and the check method of irrigation lies in the size of the checks, the basin containing only enough ground for one tree, while the check method used in orchards may contain ground on which several or even a great many trees are growing. The banks thrown up to retain the water in the basins are usually somewhat better constructed and more permanent than those in the "check" system. They are also usually much lower; as a less area is irrigated in a check. In some instances they are made so low that a cultivator may be run across them, by little lifting, without much damage to either the machine or the bank. It is commonly thought that, especially where the weather gets very hot, it is injurious to allow water to stand around the base of the trunks of fruit trees. Most farmers concur in the opinion that the heating of water in the basins by the sun will tend to scald the bark of the trees and that it may even produce wilting on hot days. To obviate this condition, usually a small mound is thrown up surrounding the trunk of the tree to prevent the water coming in contact with it. When this is done the water is applied where it

is most needed, that is, not just at the base of the tree, but some little distance out and surrounding the tree. Under this area are the small roots that absorb water and feed the tree. Unless cultivation is practiced in the basins, where the ground contains much clay, it is apt to bake badly, and crack. These cracks may even extend through the banks and the basin may need some attention to keep it from leaking. The main objection to this method lies in the very large first cost of preparing the land. The actual labor of irrigating is very small, although it is necessary to let out the water from one basin when it has stood long enough and turn it into the next one, until all are irrigated.

**METHODS
FOR CLAY
SOILS**

The furrow method, or one of the sub-irrigation methods, is best suited to all heavy soils which are not so dense they will not absorb water readily, as there is more crusting of the surface and cracking when they are flooded. With the furrow methods it is also easy to mulch either the whole surface, or that part lying between the furrows. Seepage or percolation through the soil in the furrow method is aided by leaving the surface of the furrow rough, with clods in it, so that the water flows down slowly and has plenty of time to soak to the roots of the plants.

**METHODS
FOR SANDY
SOILS**

On sandy soils, and especially on soils that are spotted with sandy or gravelly places, the flooding methods are usually more satisfactory than the furrow method. It is sometimes impossible to run a small stream of water in furrows through a loose sandy or gravelly soil, as it sinks into the soil almost as fast as it can be turned into the furrow. For short distances this may be satisfactory, but in general it is best on such soils to use a large head of water and flood the ground as rapidly as possible. The check method of flooding makes this kind of ground especially easy to work.

**METHODS
FOR STEEP
SLOPES**

The contour check method may be used on steep slopes. When the checks are made very narrow on this kind of ground, this method is called terracing. Furrows may be also used on moderately steep slopes, where they are run on grades only slightly below contour lines. Care must be taken with any method on steep ground, that the water does not get a start down the steepest slope, as it very quickly gathers force and volume and may cut the ground badly.

**METHODS
FOR SLIGHT
SLOPES**

For very level ground the check method is often found most advantageous. For slight slopes the furrow method has some important advantages over the check. Ground sloping from four to ten feet to the mile can be easily

irrigated by the check method, while ground sloping from ten to thirty feet to the mile is usually adapted to the furrow method.



Plate XVI. The Big Horn River Is a Grand Stream.
Photo by Stimson.

CHAPTER VIII.

IRRIGATION APPLIANCES.

The effect of aridity is to stimulate the thinking machine. He is most fortunate who can readily adapt himself to his environment.

HOME-MADE APPLIANCES

The farmer on irrigated land, has in many cases, either to adapt implements made for use in humid regions, to his own needs, or make new ones himself. He may have to invent implements for special purposes. More home-made appliances are found on the western irrigated farms than anywhere else. Many of these can be made quite cheaply and will serve the purpose as well as expensive tools bought from the manufacturers.

SAGE BRUSH GRUBBERS

The first work of the irrigator who has just settled on raw land is to get rid of the sage brush, grease-wood, or other bushes found on the land. Sage brush is not a deep or strong-rooted plant. The roots of grease-wood are large and very hard, but brittle. When the brush is small it is easy to get rid of it by plowing, perhaps putting on extra horses to pull the breaking plow, and following to pull out the uprooted brush by hand. Where the brush is larger this method may not do and one has to buy a sage brush grubber, made especially for the purpose, or find a substi-

tute. There are two types of sage brush grubbers on the market. One of these has a horizontal blade so fitted on the frame that it can be held some two or three inches below the surface of the ground, thus cutting off the sage brush at its weakest point. A common road grader does good work where the brush is small, by merely scraping it off the surface. The other type of grubber has teeth which catches the brush as the machine is drawn along and pulls it out. This is a modification of the old revolving rake and the brush is dumped by tipping the machine over. This leaves strips of unpulled brush so the work must be done both ways.

For moderate-sized brush an expensive implement is not necessary, as a good grubber can be made of a discarded railroad iron. A straight rail may be used, but it is better to bend the rail in the center, so when horses are hitched to each end it will drag right side up, the front flange catching, breaking off, or pulling out the sage brush. From two to six horses on each end of the rail will be found necessary. It is usually best to make a platform back of the rail and weight it to keep the rail from riding over the brush or prevent a straight one from rolling. The flat bottom of the rail must be kept down to do the work. Where the brush is not too heavy a large area can be covered in a day, by the use of this device. For heavy sage brush, where the rail cannot be used, the only recourse is to use

the mattock or grub-hoe and hand labor. With scattered or thin brush many think that hand labor is the cheapest way of clearing the land.

BRUSH PLOW

A heavy breaking plow is used with four to eight horses for the first plowing of sage brush or grease-wood land. Where many roots are encountered and the soil is hard and compact, the draft is heavy and plenty of pulling power is important. Three to five inches in depth is usually found best for breaking such ground the first year. After the first breaking it should again be plowed deeper. The mold-board plow is the best for sage brush soils, but a good disc will tear out small brush.

DITCH- MAKING TOOLS

Irrigation ditches are of all sizes, and many types of implements are needed for different conditions. For small laterals no implement is better, perhaps, than the common lister. The ordinary mold board plow may be used for this purpose, being run back and forth and throwing the earth away from the center of the ditch. For a slightly larger lateral the plow should be followed by an "A" or "Go-Devil." This may be home-made. By putting hinges on one side and a brace on the inside, the "A" may be adjusted to different widths of ditches. For larger laterals and small canals, the "slip" or the tongue scraper and the common grader are often used. For still larger canals there is no implement that can compare with the Fresno scraper.

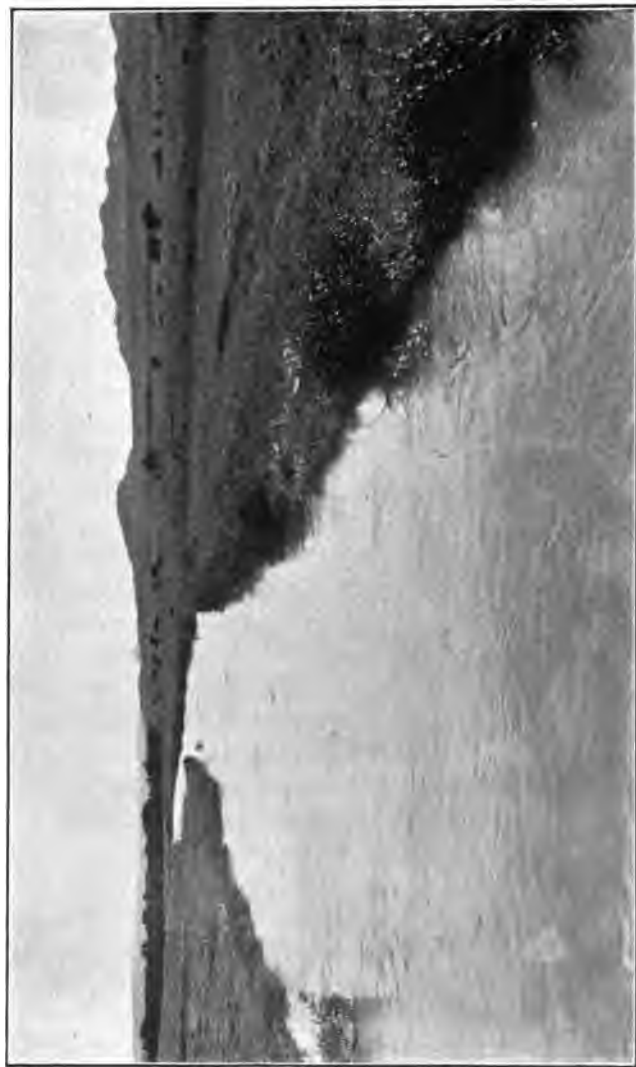


Plate XVII. Sybille Valley and Wheatland Canal.

Photo by Stimson.

**LEVELING
IMPLEMENTS**

After having cleared the brush from the land and plowed it, the next question is leveling the land, or rather grading it so that it is of a uniform slope, suitable for irrigation. For land that contains many small humps and holes, some type of grade scraper is usually best for leveling. Where the knolls are large and the hollows deeper, a Fresno or "slip," or other scraper, may be used, according to the distance the earth must be hauled to level it off. The finishing touches should be made by the home-made leveler. This is a large frame made of 2x6 or 2x8 timbers, edges down, thoroughly braced, so that they will drag along the earth from the higher places and will deposit it in the lower places. The central cross-piece should be made adjustable by means of a lever, so that it may be lowered or raised. This, as well as the other cross-pieces, should be shod with iron. The adjustable scraper can be made to take off quite a slice from a high place, as the whole weight of the machine may be made to rest on its sharp edge. These levelers may be made 16 feet long and 5 feet wide for four horses, or 24 feet long and 5 or 6 feet wide, where eight horses are used.

**SMALL
IRRIGATION
TOOLS**

The great implement used in the flooding method of irrigation is the common shovel, but there is a difference between shovels. The best irrigation shovel is one made strong at the waist, with a sharp point, and with the top of the blade

bent over so that a rubber boot will not be cut when used to shove it in. In flooding from field ditches some kind of a lateral dam must be used. The practice of damming these laterals by means of earth thrown into them from the sides of the ditches, is not to be recommended, as it is apt to weaken the ditch banks and soon makes holes in the farm. The canvas dam is easily made and is thoroughly reliable. A piece of canvas as wide, at least, as the ditch on which it is to be used, and some three or four feet long, should be tacked to a 2x4 scantling, or small pole, so that when rested across the top of the ditch, the canvas will lie in the bottom of the ditch up-stream. A little earth then thrown on the lower edge to hold it down, will make a strong dam. Perhaps no appliance is more essential than the canvas dam. Ten or twelve ounce canvas is the best weight to use. Semi-circular sheets of metal attached to a wooden cross-piece are also used for this purpose. They are called tapoons, and in use the edge of the tapoon is shoved into the bed of the ditch, which the metal should be made to fit. Gates for allowing a part of the water to continue on down the lateral may be easily made in either the canvas dam or the metal tapoon. In this way the irrigation stream may be readily divided. In making banks for the check method of irrigation, the ground contained within each check should first be made as level as possible, by means of a blade, or other

scraper, the earth that is being scraped away being left at about the location of the bank. This bank can then be shaped up by a "ridger," which is the reverse of a home-made "A," the side not being allowed to meet at the point of the "A." This instrument, drawn with the large end forward, shapes and straightens the bank. The places where the banks meet must be left unmade and these can afterward be filled in by hand or by a special machine made for this purpose, which is simply a scraper made so that its load can be easily dumped in one place. For furrow irrigation, a home-made instrument called a "marker," is used for making the furrows. It is simply a few 4x6 timbers, two or three feet long, bevelled at the lower edge and drawn along parallel to each other, being held the proper distance apart by a strong wooden frame. The front of the furrowing timbers should be slanted and shod with diamond-shaped sheets of iron. Furrows can also be made by special hoe teeth for a common cultivator. This leaves the furrows rough and loose. The furrows for beets and potatoes are usually made with a simple shovel plow, with or without wings, or with a small double or listing plow.

HEAD GATES

Small head gates are necessary for each main lateral and sometimes a larger one for the ditch bringing the water to the individual farm. When water is plentiful and drain ditches are provided

for carrying away the surplus, these gates do not have to be very carefully made, but in the end it always pays to make them well and so they may be easily adjusted to allow the amount of water required to flow down the ditch. For permanent gates on laterals heading in a large canal, iron head gates clamped to enough sewer pipe to carry the water through the canal bank are recommended, both because they are lasting and when once placed, there is less danger of a washout, which may cause greater damage or delay than there is with the ordinary wooden head gate. For the diversion of water into the different laterals on the farm, small wooden boxes with head-boards running between strips of wood tacked on the inside, are sufficient. Holes should be drilled through the handle of the gate so that it may be adjusted at any height by putting in a wooden pin at the proper hole. Sometimes trouble is caused by gates not thus held dropping down and causing the lateral to over-fill and flood all around it.

DROPS

Where the grade of a lateral is too great the water will soon cut in deeply and the result is that the lateral is too deep for easy irrigation. Such washed out ditches are unsightly and are objectionable on other accounts. To keep the water from running too swiftly when the natural grade is great, drops or spill boxes are necessary. These are simply little falls made

by setting boxes into the canal. They should be so constructed that they will not wash out. Cutting around them is prevented by wing walls and boards placed vertically to keep water from starting through or around the box. A small board dam or apron, placed at the lower edge, prevents the eddies from undermining or carrying away the structure.

CULVERTS

For carrying ditches across roads, railroads, other ditches, and the like, culverts made of pipe, are very suitable. Sometimes old boilers may be used for this purpose, but usually clay or cement sewer pipes are found preferable as they do not corrode. They should be carefully placed in line, the joints cemented and the earth tamped around them until solid. Where there is much alkali, unglazed clay pipe will only last a short time.

SMALL FLUMES

Often it is necessary to cross ditches or gulleys with flumes. These may be made either of wood or metal. In wood flumes the frame work should be made first, the trestles on which they are held being made strong enough to hold against all strains, and with a foundation made secure against settling. The settling of a flume in one or two places may cause leakage of the whole amount of water carried. The boards of a flume usually should be laid lengthwise. Several methods of closing the joints are practiced.

Sometimes matched lumber is used, but as this is expensive, it is usually more economical to use rough, but straight lumber and calk the joints with cotton-waste and tar, or with oakum. If the boards fit closely when dry, the swelling of the wood, when water is run in it, should still further close up any cracks. Some of the patent metal flumes are found advantageous as they require less attention to prevent leakage than the wooden ones and also present a better appearance. They cost considerably more in the beginning, but if they are kept painted they will last almost indefinitely.

THE FARM LEVEL

Where many laterals are to be run or contour furrows or checks are to be made, it will often be found advisable for the farmer to get a cheap level with which to survey them. Anyone can learn to use these instruments without much difficulty. It will save considerable expense for surveyor's fees. As the instrument is used only at intervals, several farmers can buy one together and get sufficient use of it to pay them well. It is also a very useful instrument for locating main laterals and drain ditches and in leveling land, grading terraces, or for a number of uses that come up on the farm.



Part IV.

CROPS AND CROP CULTURE.

*Where once was but the short grass range
There now has come a wondrous change.
O'er plateau, valley, on the plains
Are fields of green, or golden grains.
With plow, with hoe, with seed to sow
Flower, fruit and vine by magic grow.
Our hearts content with heavy yield
Of the joy of soul and the wealth of field.*



Plate XVIII. Turkey Red Winter Wheat, Dry Grown at New Castle, Wyo., 1908.
Photo by Stimson.

CHAPTER IX.

ALFALFA.

All flesh is grass and western grass is flesh par excellence.

ALFALFA IN WESTERN AGRICUL- TURE

Alfalfa has been and is the making of the West. No other plant can take its place in arid agriculture. It makes the richest hay and is the best all-round forage; is best adapted to climate and soils; it solves the problem of soil fertility and maintenance. Alfalfa is not only essential on every irrigated farm, but it is a drouth resistant hay crop for the dry farmer. Its value as a stock food has given it fame, not only in the West, but in all parts of the country. Alfalfa is now being brought into almost every state and introduced into every country in the world. Its value has become so well recognized that the demand for alfalfa seed far exceeds the supply. This makes the growing of alfalfa for seed an important new industry for this region where seed can be successfully produced.

ALFALFA SEED CULTURE

Up to the present time the production of alfalfa seed has simply been incidental. When alfalfa land has been plowed and put into grain crops the plants which come up from the old crowns produce seed. When the grain is threshed, this seed is separated and saved and



has furnished a considerable portion of the supply. Very few have planted alfalfa for the purpose of producing seed. When alfalfa fields get old, run out, and the plants thin so that they do not produce sufficient yield of hay, it is the common practice to leave them for seed. Such fields give yields of from two to seven bushels of seed per acre. Old plants produce small amounts of seed. For large crops young and vigorous plants are necessary. There are three secrets in successful alfalfa seed production. First, isolation of the plant; second, young and vigorous plants; third, favorable conditions of growth.

**METHOD OF
PLANTING
FOR SEED**

Alfalfa for seed should not be sown as the ordinary hay crop. To secure plants which are far enough apart to make strong, thrifty growth; to secure proper fertilization of the flowers; to prevent crowding; to favor cultivation and irrigation, seed should be thinly sown in rows from two and one-half to three and one-half feet apart. The method recommended is to take off the shoes or stop up the holes of a drill to make the rows as wide as wanted, and then plant as little seed as possible (two or three pounds per acre). The small amount of seed may be mixed with ashes or soil to help spread it evenly. When the plants come up, if they are too thick in the row, they may be spaced with a hoe, as with sugar beets, or when very small may be harrowed crosswise to take out part of the plants.

**CULTIVATION
FOR SEED**

Where alfalfa seed is raised under dry farming conditions, the plants may be cultivated when very small, as are sugar beets, with a cultivator supplied with "duck feet," or "bull tongues." After the plants are a year old the cultivation may be done with a disc or alfalfa harrow. After the plants begin to produce seed, it will be necessary to cultivate carefully in order to prevent thickening up from the growth of seed which is shattered off the parent plants. Under irrigation we would give the same cultivation as for dry farming, and in addition it will be necessary to ditch deeply between the rows. These ditches should be made before the plants get too large.

**IRRIGATION
FOR SEED**

Alfalfa raised for seed production should never be allowed to get dry or to suffer for water. The key to the method of raising alfalfa seed is furnished by those plants which grow along ditch banks. Such plants which are never flood irrigated, which never get dry, which are not crowded, always produce seed abundantly. If the plants get so dry that growth is stopped, an irrigation will start new growth from the crowns, which interferes with or destroys the crop.

**HARVESTING
AND
THRESHING**

The problem of harvesting alfalfa seed grown by irrigation where the rows are wide and the ditches are deep, has not been worked out. No machine has been constructed for this work.

It would seem, however, that the crop is sufficiently profitable to pay for hand work until such time as invention supplies a better method. The seed should either be placed in bundles or tied and allowed to get thoroughly dry before it is stacked. It should be threshed with the alfalfa huller. An ordinary threshing machine does not do clean work and wastes too much seed. The seed should be stored in a dry place where there is not likely to be great changes in temperature.

**PROBABLE
YIELDS**

Alfalfa seed grown in culture for this special purpose should produce heavy crops. One crop of twenty-eight bushels of alfalfa seed per acre has been reported; in another authenticated case a crop was raised of nineteen and one-half bushels of seed per acre on three acres. These yields show the possibilities of the crop. An average of fifteen to twenty bushels per acre should be secured by correct culture and treatment. With an expense of \$20 an acre, the profit ought to be equal to that from the culture of other intensive crops, like sugar beets and potatoes.

**FERTILIZA-
TION OF
THE
FLOWERS**

It has generally been believed that alfalfa, like other clovers, required the visitation of insects to fertilize the flowers. Failure of the seed crop is often due to lack of proper fertilization. It is now known that alfalfa flowers may become fertilized without the agency of insects. Alfalfa

flowers are supplied with a little trap, the springing of which insures getting the pollen where it is needed. The honey bee seems to be one of the most important agents for fertilizing alfalfa. Alfalfa is one of the best honey plants known. Every alfalfa seed raiser should keep bees.

**WILL THERE
BE A SEED
CROP**

It is impossible to tell early in the spring whether or not a crop of seed will be secured. If the season is very wet and cold and the plants make large, thick growth, it will be better to cut the first crop instead of letting it go to seed. If the blooms are light in color, and are few, if the flowers do not fertilize, but fall off, leaving the stems bare; if only one or two weak looking pods are produced in a flower truss and there is a small amount of curl in the pod or only one or two seeds appear in it, the crop had better be cut for hay. Sometimes there is early insect injury, as from grasshoppers or early appearance of leaf-spot or other disease which indicates that a profitable seed crop will not be secured. Sometimes the bloom will increase and become well fertilized later in the season, but these early indications are almost sure evidence of what may be expected.

**CLIPPING
YOUNG
PLANTS**

The young alfalfa plants sown in rows for seed should be clipped in late summer or early fall of the first season. This clipping should be done not more than half way down the plant.

Cutting close to the ground may injure or destroy the young plants. Proper clipping greatly strengthens the plant, causing it to produce larger roots and more thrifty crowns.

**CROP FOR
SEED**

The first crop should ordinarily be left for seed, in our Northern mountain regions. In any district north of Colorado the second crop is not so certain, although it is true that the second crop will often seed better than the first. This is probably due to more numerous insects for the fertilization of the flowers later in the season. Where the season is long, so four crops or more of alfalfa are cut, the first crop may be clipped or cut for hay, and the second crop used for seed.

**TIME TO
HARVEST
SEED**

Alfalfa for seed should be cut before it gets too ripe. If allowed to stand too long or there is a shower of rain after the pods are fully ripe, they will shatter and there will be much loss. It is best to cut the seed crop when the alfalfa stems are still more or less green, or when a majority of the seed pods have turned brown. The earlier ripened seed is probably best, and that which is green or immature can be blown out with the fan.

**STACKING
FOR SEED**

The alfalfa bundles or gavels from the self-rake should be piled together for protection from rain and to prevent shattering, by handling as large bundles as convenient. When thoroughly

dry, these bundles should be put in the stack. Alfalfa for seed should be stacked several weeks, or long enough to get through the sweat before threshing. Never put alfalfa in the stack when there is moisture on the outside of the leaves or stems. Much alfalfa seed is destroyed by heating in the stack. If the stacks are large, some form of stack ventilator should be used. There should be a stack bottom of poles or other material to keep the alfalfa off the ground, and open barrels or other frames may be put inside the stack to serve as ventilators. This applies to alfalfa for hay as well as for seed.

VARIETIES OF ALFALFA

The author is now growing a total of forty-two varieties and strains of alfalfa. Many of these are more properly varietal strains from different parts of the world. While there are few varieties of alfalfa on the market, the seed buyer has some choice, and it is important that he make his own decision rather than let the seedsman choose for him. The varieties offered by seedsmen are: common alfalfa, which covers a multitude of forms; Turkestan alfalfa, the seed of which has a brown or reddish tinge; German alfalfa, often identical with the seedsman's Turkestan, and Grimm's alfalfa, which is said to be an American strain of sand lucern. Plants of Turkestan alfalfa are so much like our common form that they are indistinguishable. The value of this strain is not that it is a different

type, but that the seed has been grown under conditions of drouth, which give it strength and



Plate XIX. Wonderful Alfalfa Grown in Northern Wyoming. Tallest Specimens Were Nine Feet and Two Inches High.

vigor when changed to our soil conditions. German alfalfa seed has done well in some localities, but has nothing specially to recommend it. On common alfalfa seed the discriminating planter will choose well when buying. That which is grown in the North will give better results than that which is grown in southern sections of the country. In some regions, alfalfa seed usually becomes contaminated with sweet clover. Any one with acute sense of smell can detect sweet clover seed in alfalfa. There is no way of separating it, and while sweet clover is not a bad weed in alfalfa fields (except in those for seed production), the buyer does not like to be fooled with any such adulterant. It is important that varieties of alfalfa which are resistant to leaf-spot disease and adapted to our conditions of soils and climate should be produced.

GOOD SEED

Good alfalfa seed varies in color, but is usually a bright golden yellow, or it may have a slight greenish tinge. It should be practically free from black, shriveled, immature seeds; it should be entirely free from dodder and other dangerous weeds. It should be viable—alive, and germinate promptly when planted. Alfalfa and other leguminous seeds often become so hard that they will remain in the soil a year or more before they germinate. Good seed is that which will make the strongest growth, and such seed is usually produced in the shortest season.

**SOILS FOR
ALFALFA**

Alfalfa will grow and thrive on almost any character of soil found in the West. The kind of sub-soil is more important than that of the surface. If the subsoil consists of hardpan or is filled with moisture which comes near the surface, it is not so suitable for alfalfa. Some of the strongest soils which produce the heaviest crops are the clays and greasewood lands, but it usually takes longer to get alfalfa established in such soils. With proper soil management, alfalfa will grow almost anywhere. If the soil is shallow, it requires more irrigation. If it is heavy clay, also more irrigation will be required. If the sub-surface water changes its position through the year, being several feet lower in the growing season than it is in the winter or spring, its rise will usually drown alfalfa. Alfalfa is not very resistant to strong alkali soils. At high altitudes where the season is short, more care will be needed in its culture, and under dry farming special attention to the conservation of moisture is necessary.

**ALFALFA
HAY
CULTURE**

Alfalfa is an intensive culture hay. The plant is worth all the work and attention given it. It responds to careful, persistent attention. The fact that it is easy to grow should not make the farmer careless. The profit in any kind of farming does not lie in average crops, but in producing more than average crops.

**PREPARATION
OF LAND
FOR
ALFALFA**

Sowing alfalfa in the sod or on sod land seldom results favorably. Alfalfa seed has become scarce and expensive and should never be wasted or thrown away in a poor seedbed. New land should be cultivated in some other crop at least one year before it is seeded to alfalfa. The seedbed should be moist and well packed. On this account it is advisable to plow in the fall. Where irrigation is practiced too much care cannot be given. The careful leveling and smoothing of land which is to be seeded to alfalfa is necessary. The crop is to remain on the soil for from two to ten or more years, and avoiding future expense of difficult irrigating will pay many times over. It is well carefully to level the ground and then try it by giving a flood irrigation before the seed is planted. If there are holes or bumps which are hard to irrigate, go on again with the Fresno scraper, land grader or home-made leveler. Either irrigation or sufficient length of time and attention given to conservation of moisture should always be practiced before planting alfalfa seed. It is important that there should be enough moisture in the soil to germinate the seed and give the plants their first few weeks of growth until they get eight or ten inches high before another irrigation becomes necessary.

**TIME TO
SOW
ALFALFA**

Where the seasons are short alfalfa should be sown as early in the spring as the ground can be

put in proper condition and heavy freezing weather is past. The young plants are not seriously injured by a few degrees of frost. At lower altitudes where the season is longer alfalfa may be sown any time up to the middle of August. As far north as northern Wyoming we have succeeded in securing a good stand of alfalfa where it was planted as late as the last of August.

**SEEDING
ALFALFA
FOR HAY**

Use a drill. Use a drill with press-wheel attachments. Do not sow broadcast unless only an acre or so is planted and a drill cannot be obtained. Plant the seed shallow—from one-half inch to two inches deep. The amount of seed to use will depend upon circumstances. If the seedbed is in perfect condition, moist, loose on the surface, firm below and warm, from eight to twelve pounds of good seed per acre will produce a sufficient stand. Usually the seedbed is not in good condition and twenty pounds of seed per acre is recommended. The more seed the finer the hay, other things being equal. Some growers, especially in the Eastern states, plant as much as thirty pounds or forty pounds of seed per acre. The method the author has recommended to growers is to sow ten or twelve pounds the first year, and if a heavy stand is not secured, go over the second season in the opposite direction and drill in ten pounds more of seed. This reseeding should be done the first or second year,

as after the old plants get well established the young ones are shaded or crowded out, and never make a good, thrifty growth. Seed at right angles to the direction of the wind. Under irrigation it is best to seed with the direction of the land slope, unless the land is so steep the soil will wash.

**PLANTING
WITH NURSE
CROP**

It is common practice to sow alfalfa with some nurse crop, as no return can be expected from the alfalfa the first year. When this is properly done, a nurse crop is not especially objectionable, as a stand will be secured which will produce hay the second year. Better results are always obtained without a nurse crop. The plants become stronger and will produce heavier crops of hay the second year where they have the land all to themselves from the time of planting. The best nurse crops are those grains which produce the least leaf growth or stool the least, or mature in the shortest season. Macaroni wheat is better than other wheat. Wheat or barley is better than oats. If grain is used as a nurse crop, plant it thin, using only half or two-thirds the seed used if planting without alfalfa. Winter grains may be used as nurse crops by harrowing in the spring and sowing alfalfa early, before they have made large growth. These crops mature early in the summer and leave considerable season for the alfalfa to establish itself after they are removed.

**CULTIVATION
OF HAY**

If any cultivation is attempted the first summer, it must be carefully done. Young alfalfa plants are very tender. At the end of the season, however, a light harrowing crossways of the drills may do more good than harm. If weeds are thick, they should be mowed before there is danger of smothering the young plants; but do not cut close to the ground. An excellent practice is to apply a thin coating of manure with a spreader over the alfalfa field in the fall, either for new or old planting.

It is only recently we have discovered the great profit arising from cultivating alfalfa fields. There are two indispensable implements for alfalfa cultivation: the disc, or the spiked-tooth alfalfa harrow, and the drag harrow. Cultivation should begin in earnest in the spring of the second season. If the disc is used, set the blades fairly straight. Weight the disc so that it will cut two or three inches deep. Lap it each round to leave the ground level, and do the work thoroughly. The alfalfa spiked-tooth harrow does not ridge the land like the disc and does not split the crowns of the alfalfa plants. It digs up the soil deeper, and does excellent work in loosening and aerating it. If the soil is left lumpy, follow with the drag harrow to finish the work. This cultivation should always be done in the early spring; it may be done in the fall and winter, and in many localities will pay

after each cutting, providing there is time after irrigation and before the plants get too high. Such cultivation lets air into the soil, saves moisture, kills weeds, destroys insects, makes plant food available, increases the crop.

INOCULATION

In most of our western soils alfalfa will not need artificial inoculation. By inoculation we mean supplying the bacteria which live on alfalfa roots and gather nitrogen from the air. Alfalfa will live without the presence of these bacteria, but it does not do well. These bacteria produce little nodules or tubercles on the roots, take the nitrogen gas of the air and change it into nitric acid, which in turn becomes valuable plant food, and the kind most needed in the West. Where alfalfa plants do not thrive, look yellow or appear to be in a dying condition, it is usually due to the absence of nitrogen bacteria. Artificial inoculation material has been on the market, but it has so generally failed that farmers should not spend good money for such cultures. A practical method of inoculation is to take soil from an old alfalfa field or from a place where sweet clover is growing and sow it over the field to be inoculated. A thin sowing of a few pounds per acre will get the bacteria started after which it will increase and spread. We have sent such alfalfa soil in four-pound packages by mail to farmers who have changed their success with alfalfa by sowing upon and harrowing it into their fields.

**ALFALFA
MIXTURES**

On many farms of the West sowing some grass with alfalfa is giving excellent results. Four grasses are used for this purpose, and we recommend a fifth. The four commonly used are timothy, brome grass, orchard grass, or meadow fescue. In places, no doubt, the slender wheat grass will give as good or better results than any of the foregoing. The method is to sow the ordinary amount of alfalfa seed and then put on from ten to twenty pounds of the grass selected, and harrow it in. These grasses which grow tall enough will head just above the alfalfa, and it is claimed fields produce as large crops of both alfalfa and the grass used as would be grown if each were planted alone. Such alfalfa and grass mixtures make excellent stock feed, especially for fattening, as the grasses widen the ration. Mixtures of this kind are not recommended for dry farming. Grass sod in alfalfa shortens the life of the alfalfa plants and prevents thorough harrow cultivation.

**IRRIGATION
OF ALFALFA
HAY**

Irrigate the ground before planting. Do not irrigate the seed up if it is possible to avoid it. Do not irrigate alfalfa when too young, unless you know it is burning. Many practice irrigating old fields early in the spring before the alfalfa starts, but this is probably not the best practice. Fall or winter irrigation is better. Alfalfa may be winter killed if irrigated so late that the water freezes around the crowns of the

plants. If the water is absorbed by the soil so that it does not stand and freeze, no damage will be done, or if the ground is thoroughly frozen and the water merely forms ice over the surface it does not harm the plants. Usually, the first crop can be produced without irrigation; but alfalfa should be irrigated for each of the second, third, and fourth crops. Some farmers practice irrigating just before cutting the hay. Irrigating at that time leaves the ground damp, which interferes with mowing, makes the hay more succulent, and delays curing, which may cause injury to the hay. It does, however, put moisture in the ground where it produces a quick and vigorous start from the crowns for the next crop. Alfalfa should be cut, cured, and removed from the ground as quickly as possible. Then irrigate after the cutting. It is easier to spread water on the stubble. The irrigation can be done better and does not interfere with making the hay. Alfalfa does not stand well in water. The irrigations should be as short as possible. Some of the best farmers in the West now practice furrow irrigation for alfalfa. The furrows are made with a corn marker or something of the same kind. They are usually shallow furrows, four or five inches deep, and made two feet apart. Running water through these furrows prevents flooding the crowns, and on many soils better crops are produced.

**HARVESTING
HAY**

Alfalfa for hay should be harvested when it first begins to come into bloom. The best hay-makers rake their alfalfa either immediately after mowing or as soon as it is slightly wilted. Some keep their hay in wind-rows; others bunch with a rake. Undoubtedly the best method, al-



Plate XX. A Good Way to Make Large Stacks.

L. A. K. Ranch.

Photo by Stimson.

though it takes more work, is to put the hay in cocks with a fork, as it saves much waste and insures the best curing. The hay should be stacked when it is sufficiently dry, but not too brittle. Do not put in stack when there is dew, rain, or other moisture on the outside of the stems and leaves. If perfectly dry outside, it may be

stacked when there is considerable moisture in the hay, providing the stacks are not made too large or stack ventilators are used. Always use some kind of stack bottom, even if it is no more than a layer of straw. On large fields many use the common go-devil, or ricker, to haul the



Plate XXI. The "Go Devil" and Stacker Putting Up Alfalfa.

hay cocks or bunches to the stackers. Mr. Wilcox has called attention to the Lockhart drag as an advanced method of hauling hay from the fields to the stack. This drag is made of nine 1x6 boards placed six inches apart and bolted at each end to 2x4 cross pieces laid flat. It is simply dragged over the field and a ton or more of hay tipped onto it with forks and then dragged

to the stack, where the hay is delivered to the stacker. New stacks, especially where the wind blows, should be anchored by wires over the tops and fastening weights to them.

**HARVEST
AFTER ANY
INJURY**

Do not hesitate about or delay the cutting of alfalfa at any time if its tops are injured severely by frosts, or hail, or insects, or drouth. It never pays to leave such injured alfalfa with the hope that it may recover, because the plants always make a second growth from the crowns, and the injured tops both spoil the hay and interfere with the growth of the second crop.

**STORING
GREEN
ALFALFA**

Green alfalfa may be stored either in the silo or by a new method recommended by the Kansas Experiment Station. We do not recommend silos for the West, because dry alfalfa hay is such a perfect food that there is no necessity of putting it up green. The Kansas method of storing green alfalfa is of interest. The alfalfa is hauled in as soon as possible after cutting and stored on floors, two to three feet above ground, made of poles or slats, which supply openings through which the air from beneath can pass up through the hay. These sheds are covered with some kind of roof. The alfalfa is piled from three to five feet deep on the floors, and if the weather is dry and there is no outside moisture on the stems or leaves, it is claimed will cure perfectly without heating. Such

hay contains all the leaves and retains a perfect green color, which gives it the highest value. Care must be taken not to compact the hay after it is put in.

**ALFALFA
AS A
FERTILIZER**

Any one who has had experience or who has studied alfalfa in its relation to western soils becomes most appreciative and enthusiastic about its unparalleled value. Through the agency of the bacteria on its roots alfalfa is one of the strongest nitrogen gathering plants. It grows from a large, strong tap root, which reaches the lower depths of the soil, bringing up plant food from the sub-soil, loosening compacted soils and adding vegetable matter through their own decay when the soil is used for other crops. In growing several crops in a season, which are harvested as hay, there is a considerable deposit on the surface of broken off leaves, small stems, and more especially of stubble, which dies each time from the place cut by the mower to the crown of the plant. These things add much vegetable matter to the surface of the soil. Our studies have convinced us that growing alfalfa on any soil from three to five years adds from thirty to forty dollars worth of available fertilizer when it is plowed up for the production of other crops. By using alfalfa in rotation the raising of intensive crops, like potatoes and sugar beets, is made possible, and rotation with alfalfa in parts of the West has increased the

average wheat yields from less than twenty bushels per acre to approximately fifty bushels per acre. Every farmer who can grow alfalfa, whether or not he may use the hay for stock feed, should consider this plant the foundation of his rotations in soil culture.

When used as a fertilizer many farmers simply leave the alfalfa two years. The alfalfa products themselves are so valuable that in most places when a good stand is secured it will pay to let it occupy the ground from three years to seven or eight years, or even much longer periods.

PASTURING ALFALFA

There is objection to the use of alfalfa as pasture for three important reasons. First, sheep or cattle pastured on alfalfa are very apt to bloat. The way pasturing is usually done there is a loss of animals, which may make it unprofitable. Sometimes alfalfa hay will cause bloat when overfed to sheep and cattle. The cured hay at high altitudes where the stems are fine and there is a large percentage of leaves is more apt to cause bloat. Undoubtedly the best method of feeding green alfalfa is by soiling, in which the alfalfa is cut and carried to the animals each day.

The second reason for not pasturing alfalfa is that it injures the plants. Tramping and packing the ground by stock, more especially in regions where alfalfa is hard to grow, may cause

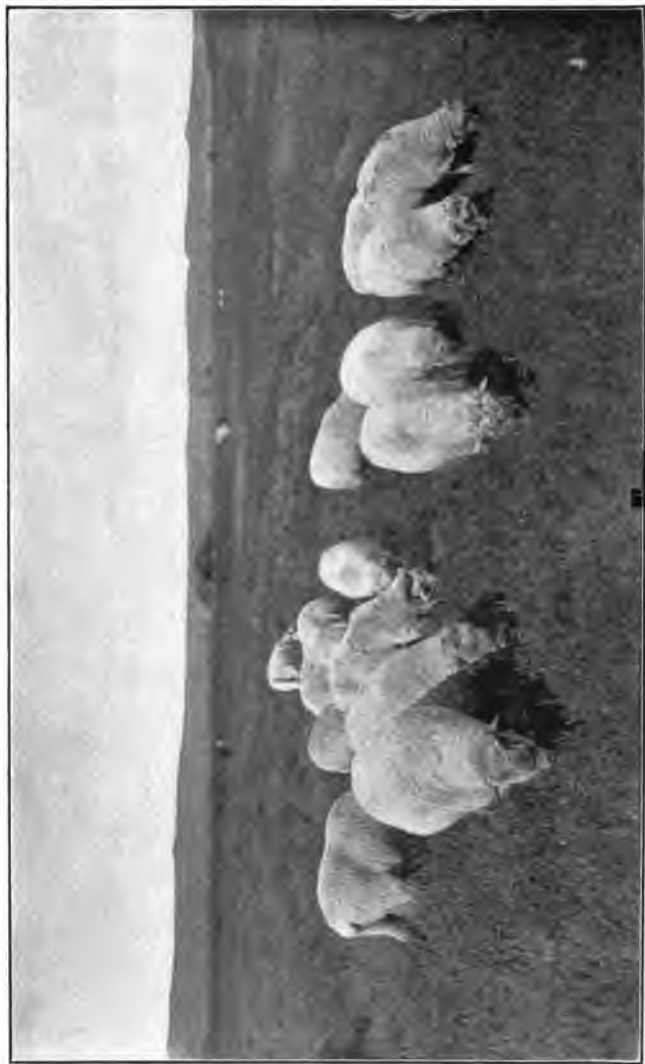


Plate XXII. Blooded Rams on Alfalfa Pasture.

Photo by Stimson.

more damage than profit from the pasture. This can be largely obviated by cultivation.

The third reason for not pasturing alfalfa is that it does much to foster and spread alfalfa diseases. One of the best remedies for our more serious alfalfa diseases is discing and aerating the soil. When soils have been compacted by heavy tramping, those bacteria and fungi which produce disease find conditions most favorable for their development and do the most serious damage.

Notwithstanding these objections much profitable pasturing of alfalfa is done. Many large ranch and range men leave the last crop to be fed off by their stock in the fall and early winter. By proper management there need be little or no loss from bloat. Sometimes the alfalfa is allowed to become more or less cured and sheep or cattle are never turned on when hungry so they will gorge themselves. They should be well filled with other roughage and after turning them in the alfalfa fields they are left there continuously. Moving them off and on to the alfalfa will cause serious trouble. Horses, swine and poultry may be pastured on green alfalfa at any time.

**VALUE OF
DIFFERENT
CUTTINGS**

The first crop of alfalfa hay is always prized as the most nutritious and valuable. It contains less moisture, becomes better matured and undoubtedly makes the best hay for horses. Some Colorado lamb feeders say the best cutting for

lambs is the first, the next best is the third cutting and the second cutting is poorest of all. The third cutting is most succulent and the best for cows giving milk.

**ALFALFA
PRODUCTS**

Recently the alfalfa meal industry has become a large and important one. Alfalfa is so rich in food elements that it practically becomes a concentrate when reduced to the condition of fine meal. This alfalfa meal is mixed with other



Plate XXIII.

things to make complete rations. It is mixed with molasses from the beet sugar factories, and sometimes called "Alfalmo." Sugar beet molasses is a carbohydrate which widens the ration and gives excellent results. The finer alfalfa meal or flour is put up in boxes and sold for poultry breakfast food. Alfalfa meal is mixed with seeds and grains for poultry, with other grains for balanced rations for hogs; still others for horses and for cows. It is probable that the hay itself will give almost as good results for cows or other animals which need roughage for

stomach distention, although it is claimed that alfalfa meal does not pack in the stomach. Some recent experiments in Pennsylvania show that if bran can be obtained for \$20 per ton and alfalfa costs \$22 per ton, it is probably more economical to feed bran. Alfalfa meal has high value for dairy cows, and it is economical if the cost of the meal is not excessive.

CHAPTER X.

HAY AND FORAGE CROPS.

The hay of the United States is its most valuable crop. In no place is forage more important to agriculture than in the arid region.

CANADA FIELD PEA

The Canada field pea is perhaps one of the most important and valuable crops, both for forage and grain, that has been introduced into the West. It is both valuable for irrigation farming and dry farming. In some sections the field pea has revolutionized the agriculture. This is true in the San Luis Valley, of Colorado, where the raising of Mexican field peas and the fattening of lambs on them has largely taken the place of grain farming.

VARIETIES OF PEAS

There are a good many varieties of Canada peas. The Mexican is a mixed or mongrel sort, which is largely grown in Colorado. The White Canada has given us the best results in all our experiments. There are several strains of these White Canada peas. We are now growing some from Sweden, France, England, Germany and other places, and some of these strains are far more productive than the common ones obtained from Canada or Wisconsin. Other forms of field peas offered by seedmen are, Green Canada, Blue Scotchman, and several forms of garden

varieties, like the White and Blackeyed Marrow-fat. The Golden Vine is one of the best known varieties.

**SOILS FOR
PEAS**

At higher altitudes, where the seasons are cool, field peas do well on almost any kind of soil. At lower altitudes where the summer is hot, the cold, heavier soils give better results. Under systems of dry farming sandy soils which retain the most moisture are the best.

**PLANTING
PEAS**

Peas are a good crop for either old land or sod, and they may be planted in a variety of ways. Good results are sometimes obtained from sowing them broadcast on the sod and covering them with the breaking plow, but such method cannot be recommended. They may be disced in or planted and covered by any method used for other seeds. The best way is to use the press drill. Forced feed drills will often crack some of the seeds; but the saving made by drilling the seed is very great in spite of this fact. Many of the split peas will grow, and the seed put in the ground with a drill will be well planted. They may be sown from one inch to four inches deep.

**TIME TO
PLANT**

Field peas should be planted as early in the spring as the ground can be prepared. In some places where the ground is dry, the seed may be sown late enough in the fall so that it will not

germinate. At lower altitudes where the season is long, the peas may be sown as late as the first or middle of July, and they will get large enough in the fall either to produce forage or to be plowed under to increase the humus and nitrogen in the soil. The best time, however, is to



Plate XXIV. Canada Field Peas. This Field Yielded Over Thirty-four Bushels Per Acre.

plant as early in spring as possible. February is not too early, if the ground is thawed out.

**CULTIVATION
AND
IRRIGATION**

Peas are easy things to cultivate. On the dry farm, under the two-year system, all they will need is a harrowing with a drag-tooth harrow after they have come up. Under irrigation peas may be managed at the pleasure of the

farmer. The pea is what the botanist calls an indeterminate grower, i. e., it grows, blooms, and ripens seed as long as there is moisture and absence of hard, freezing weather.

The amount of irrigation will depend upon the length of the season, and somewhat, also, on the heat of the summer. Where summers are hot, flood irrigating will blister or otherwise injure the pea plant. Furrow irrigation is better. They may be kept growing by irrigating often enough to keep the soil moist. We have found that on good, loamy soil four irrigations gave a yield of ripened peas of $34\frac{3}{4}$ bushels per acre, and about four tons of vines, while seven irrigations gave a little larger growth in vine, but only nineteen bushels of peas, because they did not get ripe. On account of its adaptability to different soils, different ways of planting, ease of farm management and response to dry farm methods or irrigating practice, the field pea is one of the easiest managed crops.

**FEEDING
VALUE OF
PEAS**

The pea is both forage and a grain crop. Pea hay properly made is a roughage unexcelled by any other. Poorly made pea hay is poor stuff. Good pea hay is a valuable feed for any kind of live stock. It has been found that over-ripe pea hay, pea straw, or that which has been spoiled in the stack, is dangerous to horses, cattle, pigs or sheep, because it causes indigestion and impaction. These troubles are absent when properly

made and cured hay is fed. The threshed peas are highly nitrogenous food. They are specially valuable for young, growing stock. Except for lambs or pigs which have good teeth and can grind their food, peas should be chopped or ground. Pea hay which contains ripe and partly ripe peas will make the horses slick and shiny in the spring and will put good fat on any kind of stock.

**HARVESTING
BY
PASTURING**

In many parts of the West the cheapest and best method of harvesting the field pea is to pasture with stock. In the San Luis Valley, and other places, lambs to be fattened are turned on the pea fields early in October and allowed to run for about one hundred days. These lambs may be followed by pigs, which clean up the waste peas that have been shelled out and trampled under foot. The best method is to use hurdles, or division fences, so the stock will not run over and tramp down all the peas during the first feeding period. They should have fresh food and the best supply at the end of their fattening period, and this can only be secured by using a part of the field at a time. By this method of feeding the expense of harvesting and handling the crop is saved. All that is necessary is to see that the animals are supplied with proper water and salt.

An acre of peas that makes a good crop will feed and fatten eight to twelve lambs and leave

a considerable supply of peas for the hogs which follow.

Such feeding leaves all the manure on the ground and spreads it at the same time. With the nitrogen gathering of the peas and the manure of the animals, soils used in this manner are continually enriched. Sheep will do well on peas even where some snow covers them. When the snow is too deep a plow can be run through, breaking furrows and lifting the peas so that the sheep can get to them.

**PULLING OR
MOWING
THE CROP**

If it is desired to put the peas in stack, either for the saving of seed or to feed as pea hay, or to be threshed for grain, they may be pulled with the old-fashioned dump rake, or sometimes with an ordinary hay rake. If peas are mowed, a guard attachment should be put on the mowing machine which will lift the vines. A man should follow with a fork and throw the vines in bunches or wind-rows, away from the machine, so that the horses will not tramp over them on the second round.

The best method of hauling peas to the stack is by the use of sleds and slings. If threshed for seed, a special threshing machine must be used or they must be flailed or tramped out. The ordinary cylinder machine will not only split the peas, but make pea meal of them in our dry climate where the grain gets brittle.

**COMBINING
OATS AND
PEAS**

Many eastern writers make a strong point of the value of growing field peas in connection with some grain, generally oats. It is usually claimed that the grain helps hold up the peas and increases the efficiency of both crops as food. Our experience indicates that in most places it will pay better to grow the peas and the grain separately. The grain is apt to grow more rapidly than the peas in the early part of the season, and its effect in shading and crowding the pea vines usually produces small growth or entirely smothers them. The combination for feed of pea hay and well cured oat or barley hay possesses important advantages, as it makes a better balanced ration.

CORN

The West is not a corn country. The great value of corn, however, as a forage crop and as a cultivated crop for dry farming, makes it of much importance. There are parts of the West where corn can be raised for grain with profit, but its high value is as a fodder.

Corn is one of the most productive plants we can grow in the amount of roughage produced per acre. Yields of from four tons to twelve tons per acre are obtained of cured fodder. When properly raised and cared for, corn fodder is worth almost half as much as alfalfa, and it produces a large amount of digestible food per acre.

Corn is one of the best drouth-resistant for-

age crops, and one that can be most cheaply raised. Seed costs little, cultivation may be done on an extensive scale, and shallow cultivation is all that is necessary. The land may be plowed and cultivated more shallow for corn than for any other crop. Under dry farming, with proper tools, one man can plant and tend 160 acres of corn, or of sorghum. He must have plenty of horses, gang listers, large harrows, and gang weeders.

**VARIETIES
FOR THE
WEST**

There are many kinds and varieties of corn, but they are all classified under about four heads. There are flour corns, usually grown in the South; Dent corns large and small, Flint corns suitable to the North, and sweet corns. The best varieties for the most of the West are those short season types represented by the Flint corns and the small Dents. Sweet corn is one of the most valuable sorts to grow for forage. It will produce almost or quite as much forage per acre as the common kinds. The best varieties for this purpose are the large growing late sorts, like Evergreen or Stowell's Evergreen.

Of the common corns those that will stand the most drouth, the shortest season, and coolest nights are the Australian Flint corns, the White Cap Dent corns, Cool Night corn and M. . . .n corn. Corn is one of the easiest plants to adapt to variations of soil and climate.

**CORN
CULTURE**

We recommend deep plowing for dry farming, and more shallow plowing where irrigation is done. Plowing should be as long before planting as possible in order to let the soil become packed. The usual cultivation to conserve moisture and kill weeds is important. There are two general methods of planting. Corn may be drilled in rows three or three and one-half feet apart, dropping the seed about a foot apart in the row. Or, it may be drilled more thickly for the production of fine stemmed fodder. When planted in this manner, usually from ten pounds to twenty pounds of seed per acre are sown. For dry farming the recommendation is to use a lister, planting in hills with two pounds to five pounds of seed per acre. Cultivation should begin almost as soon as the corn is planted. It may be frequently harrowed until the plants are six or eight inches high. Then it should be cultivated with a weeder until too high for this machine, after which cultivation can be done with the ordinary corn cultivators, unless there is sufficient moisture so the crop can be laid by.

**HARVEST
OF CORN
FODDER**

Corn fodder has the highest food value when it is nearly mature. It is best to leave it until the ears are just past the glazing stage. There is considerable loss in the West of food value when corn matures. It should be put in as large shocks as possible to save this loss. It does not

pay to harvest corn-stalks by turning in stock to eat them. Fodder is less valuable if left to cure in the fields, and there is considerable loss occasioned by cattle dying suddenly from corn-stalk disease. There are no bad effects from feeding cured corn fodder. Fifty pounds of corn fodder when it is in best condition is said to equal seventy-five pounds of millet or sorghum.

**SORGHUM
AND KAFIR
CORN**

The word sorghum usually designates the sweet forms which may be grown for sugar. The common non-saccharine sorghums are called Kafir corn, or Jerusalem corn, rice corns, or Dhouras. The culture is alike for all these sorghums and the general recommendation for preparation of the land and cultivation of crop given for corn is applicable to sorghum. These plants are valuable for some parts of the West. The Kafir corns grow in the hotter, longer seasons, and the Dhouras and sweet sorghum further north. They are usually grown for forage, but the grain is of great value. Ground sorghum seed has much the same nature as corn meal and has a value only a little less than corn for feeding. The sorghums have weak germinating seeds and are slow in the earlier part of their growth. The seed should not be planted until the weather gets warm, usually after the middle of May, and level culture is better than listing, as the plants should be up where they receive the sun and heat. They should be drilled in rows, three feet apart, and

when grown for forage, about one and one-half bushels of seed may be sown per acre. When grown for grain, from six to twelve pounds of seed should be used which will distribute it from four to eight inches apart in the rows. The grain may be sown broadcast and harvested with a mower for hay. The usual method of harvesting when grown in rows is by the use of either a mower or a corn binder. The yield of grain varies from twenty bushels to ninety bushels of grain in Kansas, the average being forty-five bushels. These crops will yield from four to eight tons of dry forage.

While sorghums may be more easily raised than corn, their fodder is not so valuable. They are drought resistant. They are sometimes cut early in order to produce two crops in a season. It is more advisable, however, to let the plants become more mature. If cut early, they are succulent and cattle cannot eat enough to furnish them with sufficient nutriment. They are best cut for food when the grain is in the milk or early dough stage. Dr. Headen found that good sweet sorghum gives poor feeding results compared with corn fodder or other forage.

VARIETIES OF SORGHUM

The earliest and the best variety of sweet sorghum for general planting is the Early Amber. Early Orange is good, but it requires a little longer season. The best variety of Kafir

corn is the Black Hulled White. The Red Kafir corn is usually grown where the season is long; but the Black Hulled White has given the best results in nearly all parts of the West.

MILLETS

There are four distinct forms of millet. First, the Japanese millets, of which our wild crab grass is a near relative; second, the round headed millets, like the Common, German, Hungarian, Golden, and Siberian millets; third, the Pearl millets, which have round, cat-tail-like heads, and, fourth, Broom corn, hog, or Proso millets, which are drouth resistant forms.

Of these forms the Pearl millet is suitable to the South, and will not mature in our northwestern states. The proso millets will stand more drouth and produce crops of seed where others would fail, but as a forage they are not so palatable to stock as are the other forms.

On good soils, under irrigation, Japanese millet will produce heavy yields of fairly good forage. The German, Hungarian, and Siberian millet are the ones most generally recommended. Of these the Hungarian seems to be the most palatable to stock, but the German or Siberian millet will probably produce heavier yields.

Millets are quick growing, summer crops which are quite exhaustive on soils. They are not very useful at altitudes above 6,000 feet, but at lower altitudes they produce valuable hay, especially under systems of dry farming. Millet

is a good crop to raise on new sod, under irrigation. Sow from thirty pounds to sixty pounds of seed per acre, and as with other small seeds, we advise the use of the press drill. Millets are good feeds for most stock, but they must be fed carefully to horses. It is better to mix millet with other hay, like oats, peas, or corn fodder.

**SALT BUSH
OR SALT
SAGE**

There are several kinds of salt bush (*Atriplex*) growing in parts of the arid West. These plants have high feeding value and are an important part of the forage on many ranges. The Indians have appreciated these plants for their horses. In "Captain Bonneville," Irving says that many years ago old Chief Arapooish, in telling that the "Crow-Country is a good country," spoke of the value of the Salt Weed for their horses. Just what the value of the Salt sages will be for cultivation is not known, but some of them are very promising. The best native kinds are apparently Nelson's Salt Sage, Shad Scale, and the Annual Tumbling Saltweed. The one which is most cultivated is the introduced Australian salt bush. This has proved itself of great value in California, where Prof. Charles Shinn made an extended report of it. Doctor Headden, in Colorado, has grown the plants and investigated their feeding value. He thinks this one of the valuable dry land forage crops. In California it produced over five

and one-half tons per acre of fodder, where the rainfall was less than five inches per annum. This salt bush spreads on the ground, so it is hard to mow for hay, and its great value is as pasture. It becomes an annual where the winters are cold, but produces large amounts of seed, and in Colorado reseeded and maintained itself for five seasons. It is very rich in protein and takes out of the soil a large amount of mineral matter, as it contains seventeen per cent. of ash. This salt bush spreads on the ground, so its seeds must be planted very shallow. It is difficult to get a stand, but after once started it grows under very unfavorable conditions. Salt sages are especially valuable for alkali soils.

**WHITE
SWEET
CLOVER**

Bokhara or white sweet clover is a plant which is much despised as a weed. Its good qualities are neither known nor understood. In our opinion it is one of the most valuable plants for certain conditions which we can grow in the West. It has qualities which make it a most desirable weed to occupy the waste places on the farm. On irrigated farms, which are properly managed, this clover never becomes a troublesome weed in the fields. It does become more or less troublesome, however, in some dry farm areas, because it is persistent and will spread even in the native sod. Its qualities are, its great hardiness; it will grow on soils too poor for other crops and also on strong alkali soils; it will stand more

drouth than any other clover; it is hardy enough to produce well at our higher altitudes and is so strong in its growth that it will produce a large amount of vegetation to plow under as a green manure.

Sweet clover is one of the strongest nitrogen-gathering legumes. The bacteria on the roots of sweet clover are said to be the same as those which live on the roots of alfalfa, and soil from sweet clover land can be used to inoculate alfalfa fields with the nitrogen-gathering bacteria. We have never examined sweet clover roots without finding the nodules. On this account it is one of the very best plants to grow for enriching the soil in nitrogen.

Sweet clover makes a stock feed which is valuable if it is properly treated. Breeding this plant has been commenced with the hope of producing a variety which will not have the bitter and sweet flavor which makes it unpalatable to stock. As it is, hay properly cured and fed, give remarkably good results. A number of cattle men have testified that they had little difficulty teaching their stock to eat sweet clover hay and that they did well on it. In some experiments carried out at the Wyoming Experiment Station, sweet clover hay was fed to fattening lambs with corn and other grain, and the butcher who dressed the lambs testified that they were the heaviest and fattest he ever saw.

Sweet clover is one of the best honey plants known.

Its general appearance on a place and its values, as indicated, makes sweet clover better as a weed, filling up the waste places, than Russian Thistle, cow weed or a host of more pernicious and worthless plants.

**MAKING
SWEET
CLOVER HAY**

Sweet clover should be planted thick. Use twenty-five or thirty pounds of seed per acre if planted for hay. It must be cut when young, before the plants get coarse and woody. The green plants are full of juice and the hay must be cured in the wind-row or in small cocks. It should be allowed to get quite dry before putting it in the stack. When stacked, sprinkle in the hay five to eight pounds of salt to each load, then let the hay stand in the stack two years before feeding it. This method of curing hay two years is little used in the United States, but it is a common practice in England to pay a premium for horse hay which is two years old. Sweet clover hay is both strong in flavor and richer in protein than any other plant we have grown. Chemical analyses in Wyoming showed eighteen per cent. of protein. This indicates that the hay is very rich. On account of this richness it must be fed with care in order to make stock eat it successfully. If fed too much, animals will as quickly lose their appetite for it as they would if overfed with grain or other rich food.

**NOT A
DANGEROUS
WEED**

Sweet clover is a biennial plant. It lives only two years and the whole plant dies. Because of this fact good farmers need never fear the plant as a weed. If not allowed to go to seed the second year it will entirely disappear. We recommend the planting of sweet clover on grease-wood, alkali or other poor soils, letting it grow only one to two feet high the second season and plowing it under to increase the vegetable mold and nitrogen in the soil.

**DWARF
RAPE**

Dwarf rape is one of the valuable forage plants to be grown in the West. Its use is entirely as late fall and early winter pasture. This is an alkali resistant plant of much value for such portions of the farm as are unproductive for other crops through the rise of alkali. Only dwarf rape should be planted. Other varieties have no value except for bird seed. Rape grows best in the cooler portions of the year, and although a hard frost will stop its growth, it does not destroy its value as feed. It may be planted either broadcast or in drills, using from two to four pounds of seed per acre. It is useful as a catch crop to be sown in the grain field for the production of pasture after the grain has been harvested. As a forage it is especially valuable for sheep and hogs. Cattle like and do well on rape pasture. It will not do for milch cows, because milk and butter become tainted. The dairy products will seem all right for from

twelve to twenty-four hours after they are first fresh, but in a day or two they develop most unpleasant odors and flavors where rape is pastured. Rape is an annual plant, so it is necessary to sow it each year. Stock will sometimes eat too much of it if turned into a field when hungry, and in such case it causes bloat. Sow rape any time up to the first of July. No doubt the fattening qualities of rape have been exaggerated, but as pasture or a forage to be used in connection with other feeds, it will give good returns for the cost of raising.

KOHLRABI

As yet Kohlrabi is little known in the West, but it is a crop which will be valuable for stock forage. It is usually grown in gardens and used as a table vegetable. Kohlrabi is one of the more drouth-resistant plants of the cabbage family, which produces thickened stems above the ground. The thickened stem and leaves are valuable stock feed. It grows with comparatively little moisture, and may be either harvested and fed to stock for soiling or pastured in the fall. The seed should be planted the same as turnips, preferably in drills, and may be planted in the early spring in the open ground or the plants raised in boxes and transplanted.

**GRASS FOR
PASTURE**

In the farming sections of the West, where alfalfa is largely grown, there is increasing interest in grass pastures for cattle and sheep,

which will be safer than alfalfa pasture, and which will produce more than our native grass lands. The percentage loss of cattle or sheep pastured on green alfalfa is too great. Some ranchmen are becoming interested in growing early lambs for market on their farms and others are milking cows where open range is limited or



Plate XXV. Putting Up Native Hay in North Park.

not available. Sage brush range or native weeds do not give nourishment enough and also do much to reduce profit and pleasure from the use of the milk, cream, or butter, and milk from cows on such pasturage is unfit for the manufacture of cheese. There is real demand, therefore, for tame grasses to be sown for pasture alone.

**LOCAL
CONDITIONS
DIFFER**

There are many pasture grasses which succeed in the West, and some are more suitable for their localities than others. We have found none which produce a large amount of feed without irrigation or moisture conservation on our

dry uplands. There are many places, however, where winter rye succeeds without irrigation. If planted early in September, winter rye will produce considerable winter and early spring pasture, and the early rains supply moisture enough to mature a crop of grain. Several of the native grasses, notably the Western Wheat-Grass, can



Plate XXVI. A Field of Awnless Brome Grass.
Dry Grown. Photo by Stimson.

be greatly increased in unirrigated meadows by seeding and harrowing. Under irrigation, even though there may be only water enough for winter flooding, or a single irrigation in the summer season, the number of pasture grasses from which to choose is much larger. In mountain meadows, or where there is abundance of water,

timothy, redbtop, Kentucky bluegrass, and orchard grass all find a place. In many parts of the West, Alsike clover and sainfoin or French clover do well, and they are said not to be dangerous to stock from causing bloat. Brome grass is proving of great value.

GRASS MIXTURES

As a rule, if land is to be seeded down to pasture, a mixture of suitable grasses will give better results than planting a single variety. Where a moderate amount of irrigation can be given the land, we suggest a mixture of Slender Wheat-Grass, six pounds; Tall Meadow Fescue, six pounds; Brome-Grass, the Awnless Brome-Grass, or the Western Brome-Grass, six pounds; Kentucky bluegrass, four pounds; and to this may be added of Sand or Hairy Vetch, eight pounds. This makes a total of thirty pounds of seed per acre, and we suggest trying the Vetch on a part of the land until its merit may be tested. An irrigated meadow planted to these grasses may become sod-bound after a few years, but this can be avoided by properly discing or harrowing the sod.

SELLING HAY BY MEASURE

There are few western ranches where the facilities for weighing hay are present or convenient. On our larger ranches where wagon scales have been purchased, the owners seldom go to the trouble of weighing the hay which they sell from the stack. It is probable that the usual

method of measuring hay seldom gives accurate results. In the first place, the measurement itself is only an estimate of the number of cubic feet of hay in the mow or stack; in the second place, the number of cubic feet of hay which is required to weigh a ton varies greatly. If a mow is full of hay, it may be squared up. Simply multiply the height by the width, and this by the length, which will give the total number of cubic feet. Stacks in the field, however, have no square sides or peaked top. There are five methods in general use for measuring stacks:

First, the one known to most farmers is to measure the distance over the stack by throwing a rope or a tape over from one side to the other, letting it come to the ground. To this distance add the width of the stack, in feet; divide by four to get the square of the end of the stack; square this number to get the square feet, and multiply by the length to determine the total number of cubic feet.

Second, take one-third of the over and multiply by the width for the end surface, and multiply this result by the length.

Third, subtract the width from the distance over; divide by two for the height; multiply this by the width, and this product by the length.

Fourth, multiply the width of the stack by the distance over, and this product by the length and divide by four. This method has been



Plate XXVII. Timothy Hay Raised by Irrigation on Native Sod—The YU Ranch.
Photo by Stimson.

found to give results too small, sometimes as much as thirty per cent.

**BEST
METHOD OF
MEASURING
HAY**

The formula worked out by the Bureau of Plant Industry of the U. S. Department of Agriculture is given as follows:

$0.225 (O - W) OWL \div H$. O is the distance over the stack; W is the width; L the length, and H the height. First, subtract the width from the distance over; then multiply by the distance over; this by the width, and this product by the length, and this whole product by the fraction 0.225, and divide the result by the height of the stack. All the measurements must be in feet and fractions of a foot. Working out the problem in this way gives the total number of cubic feet in the stack.

It is claimed that this rule gives results with not more than from two to four per cent. error. The number of cubic feet making a ton of hay is divided into the total number of cubic feet in the stack to determine the number of tons.

**NUMBER OF
CUBIC FEET
IN A TON**

The cubic feet of hay making a ton will vary with the amount of time the hay has settled, with the kind of hay, with the amount of moisture it contains, with the weather and various other factors. It is generally conceded that 500 cubic feet of well pressed timothy hay is required to make a ton. When the timothy is first

put into the stack, or if it is too ripe, coarse, or loose, it will take seven hundred cubic feet. For alfalfa which has settled thirty to sixty days, we usually figure as a ton a cube eight feet on a side, or 512 cubic feet. For fine native hay or alfalfa that has settled six months or more, a cube seven and one-half feet on a side, or 422 cubic feet is considered sufficient for a ton. Some native hay will be found heavier than this. It is probable that the general estimate of 512 cubic feet would give but small error for good alfalfa hay.

CHAPTER XI.

GRAINS.

The grains are our most highly domesticated plants. Their wild forms are not known and they would disappear from the earth if not cultivated by man.

BARLEY

Barley is a valuable and important crop for the arid region. Our bright sunshine and dry cli-

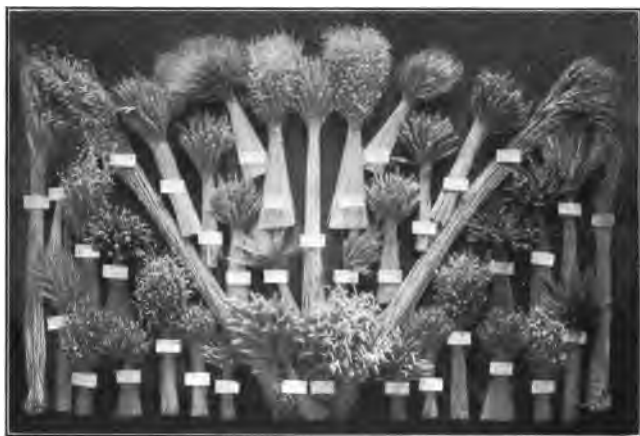


Plate XXVIII. Some Grains Grown at an Altitude of Over 7,000 Feet.

mate gives all our grains superior whiteness and clean appearance. Barley should be more generally raised in the West as an export grain crop.

In Europe white brewing barley is used for making the pale ales and in our breweries in this country much of the eastern barley must be bleached before it is suitable for the manufacture of beer. Barley produces heavier yields than wheat and usually sells for better prices. It is a short season crop and one which is of great value for stock-feeding purposes. The farmer in considering barley has unpleasant thoughts because barley beards are troublesome to man and beast. Perhaps barley has more distinct types of grain and growth than any other cereal. There is winter barley and spring barley; there are bearded brewing barleys with two-rows, four-rows and six-rows. There are bearded six-row barleys which are hulless. There are beardless hulless barley and beardless two-row and six-row barleys which retain their hull. The color of brewing barley is white, blue, and black, and the color of hulless barleys ranges from purple through the blues and greens to cream white.

**TWO-ROW
BLACK
BARLEY**

This barley has not been very largely used in the arid region. It is one of the most valuable, however, for drouth resistance and for raising at our highest altitudes where farming is practiced. This barley produces a large head, a long, strong beard and large plump grain and a comparatively soft straw. It must be threshed and the grain is valuable for feed.

**HULLESS
BARLEYS**

There are several bearded hulless barleys which are valuable grain. The principal one is the blue or purple hulless. This barley is very heavy and at St. Louis a sample from Wyoming weighed sixty-seven pounds per bushel, being the heaviest grain on exhibition from any part of the world. The most generally grown hulless barley is the "Bald" or "Beardless barley." This is a six-row grain with the beards aborted into a curl or three-cornered scale on the top of the grain. The principal objection to this barley is that the heads are carried on very weak straw, and if allowed to get too ripe there is considerable loss by their breaking off in the field or in handling. Another objection to all of the hulless barleys is their hardness. The grains are so compact and hard that it is almost impossible for animals, even with good chewing teeth, to grind them, and to feed successfully they must be either cooked, soaked or ground

**VARIETIES
FOR
BREWING**

The best brewing barleys we have grown at high altitudes and in the northern district of irrigated America, are the two-row types, "Goldthorpe," "Chevalier," and "Hanna." One of the six-row types is "Mansury." There are many others now being made by breeding and selection, especially some valuable new sorts from Sweden, but they are not on the market and available so the farmer can get the seed.

**THE
BEARDLESS
BREWING
BARLEY**

There are two forms of beardless brewing barley. One is a small two-row barley not yet in general cultivation and the value of which has not been determined. The other is a larger six-row barley which, under good conditions, produces excellent growth of straw and large, well-filled heads. This is one of the most important feed grains the western farmer can produce, whether he dry farms or irrigates his land. The straw is soft, sweet and nutritious. The grain can be cut in the dough stage and fed to stock in the bundle without threshing. There are no beards, and stock fed a ration of this barley in the straw, and alfalfa, seem to thrive and fatten remarkably well. The objection to this barley is that of the other beardless sorts. The heads become brittle and break off or shatter in handling when it gets too ripe.

**BARLEY
CULTURE**

Many complain that they do not get as good crops of barley as they have a right to expect. This is generally because they do not follow the correct method of culture. Barley needs a large amount of moisture in the early part of its growth. It needs a goodly supply of available nitrogen in the soil. If these things are absent the barley injures very quickly. Its tendency, when injured by drouth or lack of plant food is to make very short straw and small, poorly-filled heads. Barley does not show its injury by drouth as do other grains by burning and shrivel-

ing up. Before the farmer knows it his barley field may become too dry and subsequent irrigation does not make it recover as it will oats or wheat. Barley soil should be prepared in the fall or irrigated before plowing in the spring. The soil should be watched and if getting dry, even when the plants are very small, irrigation should begin. If the plants are kept moist until the barley is well headed, irrigation may stop and a good crop will be secured. Barley may be planted on new soils or better, on soils which have been in rotation, following potatoes, peas or alfalfa.

OATS

Oats are the first and most general crop raised by the arid farmer. Farmers know more, perhaps, about this grain than any other. Oats are one of the best crops to raise on sod. They always find home use as feed for teams or other stock, and there is usually a good market for the surplus. Oat culture is as simple and easy as that of any of the grains. Early varieties will mature with comparatively little moisture, but they respond to frequent irrigation and much water better than other grains. Oats on sod land may be irrigated every week or two and when they are high enough to begin to shoot, they should be thoroughly soaked by a complete irrigation.

VARIETIES OF OATS

Perhaps the best drouth resistant variety for general cultivation is the Kherson or the Swed-

ish Select. Some most excellent short-season varieties also are Scottish Chief, Lincoln, Black Beauty, Big Four, and Clydesdale. The best yielding varieties are those which take the longer season to mature. The White Russian side-oat has produced heavier yields, perhaps, than any other in general cultivation.

WHEAT

Wheat is one of the most important grain crops for the western dry farm and has its place in crop rotations under irrigation. The average yield of wheat in the arid region approximates twenty-five bushels per acre. In round numbers this is twice the average yield of the humid states. Good farmers, however, are not satisfied with yields of less than forty or fifty bushels per acre. Wheat should give a net profit over and above the expense of producing it, of from twelve to fifteen dollars per acre.

WHEAT SOILS

Wheats succeed best on heavier soils, providing they have good drainage and do not contain too much alkali. Light soils are not so favorable for wheat, but under dry farming loamy soils which are somewhat more retentive of moisture will give best results. Our soils are sufficiently rich in mineral plant foods, the only fertilizing needed being tillage and rotation with peas, alfalfa or potatoes. Wheat ought never to follow other grains and there should seldom be raised two successive crops of wheat on the same land.

**PREPARA-
TION OF
SOIL.**

Wheat succeeds much better in a well compacted soil. Fall plowing or early spring plow-



Turkey Red.

Red Cross.

Plate XXIX. Winter Wheats, Dry Grown,
New Castle, Wyo.

ing will usually give best results. Under irrigation deep plowing is not so necessary or advisable as it is for other crops. The land should be harrowed to form a good seed bed and save moisture.

**VARIETIES
OF WHEAT**

There are a large number of varieties of spring wheat which may be successfully grown in the West. In Utah, eastern Oregon, Washington and in the Southwest, the square head wheats or club wheats are grown because



Plate XXX. Some Western Flour Wheats.

By Permission of the Wyo. Exp. Station.

they do not shell out and may be allowed to get fully ripe in the field so they may be harvested with combined harvesters and threshers, or headed and taken at once to the threshing machine. In the northern portion of the mountain region the Fife and Blue Stem, known as Northern Hard wheats are the best milling sorts. For the southern half of this region wheats of the Defiance type or White Touse are the leading varieties. For dry farming the most successful and valuable spring wheat is the Kubanka type of Durum wheat. For feeding purposes, the Macaroni, Polish, and Egyptian wheats are valuable drouth resistant kinds. As yet there is only one variety of winter wheat which can be recommended for general planting. This is Turkey Red, which is a fine milling wheat, and succeeds under both systems of dry farming and irrigation. Karkof winter wheat is being tried and so far all reports are most favorable. The Silver King, which is a beardless winter wheat, has succeeded fairly well in some sections of the West.

PLANTING THE SEED

Seed wheat should be plump, heavy, true to type, clean, free from weed seeds or other grain, and treated for smut. (See Chap. 18.) The average amount of seed to use per acre on irrigated farms is about seventy pounds. Of the larger standard kinds, like Macaroni or Polish wheat, ninety to one hundred pounds may be

used, and for dry farming, thirty to forty pounds of seed per acre. These figures are good average amounts to use if sown with a press drill. If necessary to sow broadcast a third more of seed should be used. On rich lands with rotation and irrigation, only thirty pounds of seed per acre of spring wheat gives maximum yields.

The time to sow wheat is as early in the spring as the ground can be prepared and when danger of hard freezing of the soil is past. The seed should be drilled two to three inches deep. Winter wheat may be sown any time in September if the ground is moist and the seed bed well prepared. If the land slopes so much that it washes badly, the drill should be along the hill instead of straight up and down it, so the growing plants will check the force of water.

IRRIGATION OF WHEAT

There should be sufficient moisture in the soil to secure seed germination and to supply the plants until they become well established. If the ground is dry and there is not sufficient spring rain, the land should be irrigated before the wheat is planted. The plants should not be allowed to suffer for water, but on the other hand, it is better not to irrigate them until they are five or six inches high or large enough to partially shade the ground. Short, quick irrigations, which soak the ground pretty well are better than allowing the water to run too long. Generally, irrigation should be given when the plants

begin to shoot, that is, when the first stems begin to be thrown up. Another irrigation should be given after the heads are formed to insure large heads and filling of the grain. If the weather is very dry and hot, care must be taken with late irrigations of wheat, because if kept too wet at this time it might induce rust to cause considerable damage. Where the straw is badly rusted it seldom produces plump wheat and if rust is present it is probably better to keep the water off. Some farmers in the southwest believe that the shattering of the grain may be largely prevented by giving late irrigation. This is true because the grain does not get so ripe. In many cases late irrigation may result in damage by frost.

TIME TO HARVEST WHEAT

Wheat should be harvested before it gets too ripe. Experience indicates that the best results are obtained by cutting wheat in the last part of the dough stage. Such grain usually ripens in the straw and makes heavier seed. Harvesting early prevents loss by shattering. East of the mountains it is well to allow the bundles to stand in the shock for some time to go through the sweat and dry out before stacking.

WHEAT AS FEED

If properly fed wheat has been shown equal to corn for fattening stock. Some successful feeders in the West head their wheat and feed it to stock without threshing. This is one of the best methods of feeding wheat, as it is not so apt



Egyptian. Plate XXXI. Some Western Feed Wheats. Polish.
By Permission of the Wyo. Exp. Station.

to throw animals "off feed," as giving them the cleaned grain. Some of the beardless wheats may be fed in the bundle. Bearded sorts will need to be threshed.

RYE

Rye is not appreciated as it should be. In the West, rye is not raised to any extent for the production of flour. There is some prejudice against rye as stock food. There is, perhaps, no more valuable grain for the feeding of swine than rye and it should be more generally raised for this purpose. Rye hay is of much value in some sections. When raised for hay it should be planted thick and cut when in the milk or early dough stage. The winter rye is one of our most hardy grains and one of the most important ones for the dry farmer. It succeeds in almost any part of the arid region, and on new dry farm lands produces over forty bushels per acre as a maximum crop. Rye sometimes lives several years and produces a number of crops with one planting if cut in its early stages.

**RYE
CULTURE**

Rye may be planted early in the fall, the last of August or any time during September, and the young growth may be used for pasturing stock either in late fall or early spring. The ground should be well filled with moisture before the rye is planted, but this crop will stand winter drouth and cold. It should be harrowed one or more times in the spring and if water can

be had for irrigation and there is not abundant rainfall, it should be irrigated about twice.✕ The first irrigation should be a thorough soaking when the rye is in the "boot" or begins to "shoot." The last irrigation may be given when the rye is in the early dough stage to fill it and make an abundant crop.✕ Rye will grow on poorer soils than any other grain, and even under most adverse conditions will give some kind of crop. As yet there are no improved varieties of rye on our markets. This grain has been bred to great perfection in parts of Germany, where single farmers have devoted years to grading and adapting special strains of rye for their localities and soils.

**RUSSIAN
SPELT—
EMMER**

✕ De Candolle believes that Spelt was the corn, *par excellence* of Pliny, which he said was used as food by the Latins for 360 years before they knew how to make bread.✕ It has been cultivated principally in Germany, where it is called Spelz or Dinkel. Spelt, or Emmer, is one of the primitive forms of wheat, but resembles barley in character, as it is bearded and the grain is held tightly in the chaff, little or none of it shelling out when it is threshed. Spelt is receiving much attention in this country as stock food. Much is being claimed for it as a drouth-resistant grain. The North Dakota Experiment Station reported that Spelt produced heavy yields, especially good results being obtained with home grown seed.

Analyses made at the South Dakota Experiment Station shows a composition resembling that of barley. The spring spelt should yield from twenty-five to seventy-five bushels threshed grain per acre. A new spelt has been introduced and is being increased and improved, by breeding, in Wyoming. This is called Black Winter Emmer and differs from the ordinary spelt in its season of growth, color, hardiness and yielding quality. It is a winter grain of great importance, as winter grains are more valuable to the dry farmer.

**FEEDING
VALUE OF
EMMER**

In Dakota it has been found that spelt fed to steers produced as good quality of meat as corn. It took one and one-fourth pounds of spelt to equal one pound of corn in steer feeding. In feeding beef during a grass period, however, it took only 5.16 pounds of spelt for one pound of gain and at the same time it took 7.03 pounds of corn for one pound of gain. With baby beef feeding it took 1.84 pounds of spelt to 1.69 pounds corn, to produce one pound of gain.

In my own experiments with lamb feeding in Colorado a high value was shown for spelt. The lambs eating spelt consumed more of both grain and alfalfa hay than those which were fed corn.

The following tables give a brief statement of the results:

LAMB FEEDING TRIALS.

FEED.	Amt. of feed eaten.		Grain eaten for 1 lb.
	Grain pounds	Alfalfa pounds	Gain pounds
Spelt	430	889	3.03
Corn	402	803	3.09
Barley	402	888	3.43

THE GAINS AND COST OF GAIN.

	Gain of Wool pounds	Gain of Meat pounds	Total gain pounds	Cost per lb. of gain cents
Spelt	15	127	142	4.28
Corn	17	113	130	5.25
Barley	20	97	117	4.95

These experiments show a high feeding value for spelt. When we consider that spelt will yield from a third more to twice as much as corn; that it is a drouth-resistant grain, and that it is better suited to a cool climate or one with cool nights than corn, its value in the arid region becomes apparent.



Plate XXXII.

CHAPTER XII.

POTATO CULTURE.

Sir Walter Raleigh took the potato to England. It became the poor man's bread and meat in Ireland, and came back to America an Irish Potato.

THE POTATO AS A DRY LAND CROP

Potatoes can be produced with as little moisture as any of the general farm crops. Their



Plate XXXIII. John Gordon and His Dry Farm Potatoes.

requirements are such that a little water stored in the soil will make sufficient growth of vine, and with proper cultivation its feeder roots will gather practically all the moisture in the culti-

vated area. The potato is one of the more important and profitable arid region productions. So important has it become under irrigation in certain sections that its culture is being rapidly extended. When grown under irrigation the potato is forced and rapidly deteriorates as seed. On this account there is large demand for potato seed raised by dry farm methods. Seed raised by dry farming, and used under irrigation, seems to do well the first and second years, but old potato growers seldom use the same seed the third year. This is an important item to the dry farmer who has soil and conditions suitable for potato culture.

**AS AN
IRRIGATED
CROP**

Good crops of potatoes are raised on a variety of soils. We believe a light sandy loam is preferable, but where late water can be supplied, good crops are produced on heavier soils. With proper cultivation the yields average from 100 to 250 sacks of two bushels each per acre. The cost of producing the crop averages about thirty dollars per acre.

VARIETIES

The main croppers in the mountain region are the "Ohio" for early crops, the "Mammoth Pearl," and "Rural New Yorker" for late crops. In some sections the "Burbank" does very well. Early varieties are more used for dry farming, but very few early potatoes are grown as main crops by irrigation.

The white varieties (Pearl and Rural) take the lead. It is important that a community of farmers who are just becoming established, at least, plant only one or two varieties in order that they may supply a uniform product to the market in sufficient quantities.



Plate XXXIV. Potatoes on the YU. Ranch, Big Horn County, Wyo.

Photo by Stimson.

**THE
TREATMENT
OF SEED**

The root rot (See chapter 18, Plant Diseases) and blight are very common potato diseases and the first of these, at least, can be measurably controlled by properly handling and treating the seed before planting, by change of seed and by rotation of crops. Seed potatoes may be kept from sprouting in the spring by frequently changing their position in the root cellar.



Perhaps one of the best treatments that can be recommended is to let them become well sun-burned. The light seems to destroy the winter stage of the root rot disease. The farmer can tell whether this disease is present in abundance on his potatoes by the presence of black spots, which look like particles of soil that stick very tightly to the skin of the potato. "Greening" the potato seed also causes short, strong sprouts which do not break off in handling and are ready for business as soon as planted in moist soil.

**CORROSIVE
SUBLIMATE
TREATMENT**

Treatment with corrosive sublimate or formalin will also help destroy this disease, and it is a cure for true potato scab where the crop is raised on clean land. Use two ounces of corrosive sublimate to fifteen gallons of water. Dissolve the corrosive sublimate in one gallon of boiling water, using an earthen or glass jar. Mix with water in a barrel and dip the potatoes, leaving them in the solution one to one and one-half hours. Spread out to dry before cutting. Corrosive sublimate is a deadly poison and must be handled with great care. Never use the same vessel for any other purpose.

**CUTTING
THE SEED**

Small potatoes may be used for seed if they are pure and true to type, and will give as good results as will planting larger tubers. They may be either planted whole or cut, one or two eyes to the piece. The best results in cutting have been

obtained by quartering the potato lengthwise, and if a cutting block is used, the larger ones may be quartered by splitting both ways. Where potatoes are planted on a large scale a machine cutter may be used.

SEED POTATOES

Seed potatoes should be pure varieties, true to type, and not forced by irrigation. It is more important that the seed potato be one from a thrifty hill which contains a good number of potatoes true to type than that it be large size. The best seed for irrigation is raised by dry farming or at high altitudes in the mountains. The seed should be as free as possible from scab and the root rot disease, must not get chilled or frosted, and should be changed often where there is tendency to run out. A farmer who would raise potatoes successfully must not hesitate to pay the price for the best potatoes to renew his seed.

PREPARA- TION OF THE SOIL

Potato ground must be plowed deep. Usually four horses are put on to a fourteen-inch plow and the furrow turned eight or ten inches deep. If on sod ground, five or six inches will do the first year. The ground should be harrowed the same day it is plowed and the plowing should not be done long before planting time. Sod ground should be disced before the plowing is commenced in order to make as fine a seed bed as possible after it is turned under. Alfalfa



Place XXXV. Planting (Below), Harvesting (Above).
Photos by Bennett.

ground to be used for potatoes must be plowed deep and a wide, sharp share used to cut off the roots.

PLANTING

The best results are obtained by the use of a good potato planter, and such machinery is necessary, if potatoes are to be raised on a large scale. The seed should be put in an average depth of four inches when on dry, sandy soil, though they may be planted six or seven inches deep and still give good results. They are not planted deep enough as a rule. Immediately after planting, a good four-horse cultivator should be run through between the rows, loosening the ground to the depth of the plowing, or, if possible, an inch or two deeper than it was plowed. Use a four-horse cultivator and run the shovels close to the rows. Follow the cultivation with the harrow to level the soil and establish the mulch. Just before the potatoes come through the ground, give a second harrowing with a toothed harrow, slanting the teeth a little back. The seed may be dropped distances of from twelve to eighteen inches apart in the row and the rows should be from three to three and one-half feet apart. From five hundred to seven hundred pounds of seed per acre is sufficient. At higher altitudes, where the season is short and potato vines make comparatively small growth, they may be planted correspondingly closer together with the required increase in the amount



Plate XXXVI. Cultivating (Below) and Ditching
(Above).
Photos by Bennett.

of seed. The largest yield of which there is any authentic record in the West was obtained from potatoes planted a distance of eight inches apart in rows two and one-half feet apart, on highly fertilized and cultivated ground.

CULTIVATION

Potatoes should receive deep and thorough cultivation. When the plants are four or five inches high, cultivate deep and near the rows. This should be done each week or ten days, running the cultivator shovels farther from the plants as they grow larger, and throwing the soil toward the rows. The ground should be kept well stirred to the depth of the plowing between the rows until time for irrigation. Each irrigation should be followed by shallow cultivation to break up the crust until the vines get so large they interfere.

IRRIGATION.

Potatoes should not be irrigated until after the young tubers are set on the vines, though where the season is so dry they burn, it may be necessary to irrigate at any time. The tubers usually set a week or ten days before the plants begin to bloom. Deep ditches should be made, with a double plow, between the rows, and the first watering should be very light. Run the water in the alternate rows and in a week or ten days run a good head quickly through the rows which were not irrigated before. This should be followed in from a week to twelve days with a

thorough soaking up of the ground, running the water between each of the rows, but do not let it stand too long. Water should never come in contact with the crowns of the plants. If a large crop is the principal consideration, the potatoes should be irrigated once in a week or ten or twelve days through the season after starting, as indicated above. They must not be allowed to get dry enough to check their growth. After the growth becomes checked once, new irrigation will start second growth, which produces large vines, new setting of tubers or knotty, ill-shaped potatoes. If it can be avoided, irrigation should not be done when the weather is hot and sultry.

**POTATOES IN
ROTATION.**

• Farmers who make a business of potato raising follow a regular system of rotation in which alfalfa is the crop used to bring back the soil fertility. Potatoes do well on sod land and one or two crops may be raised. This should be followed with a crop of grain, and if the soil conditions are favorable, alfalfa may be sown with the grain. The alfalfa is left in the ground two or three years. It is then plowed late in spring after the alfalfa plants have started. This plowing is difficult and must be thoroughly done. The deep cultivation immediately after plowing will pull out the principal roots and prevent their interfering with future cultivations or ditching for irrigation. Such alfalfa ground may be kept in potatoes two years if disease does not appear,

and then put back into alfalfa with grain. Field peas are an excellent crop to rotate with potatoes in dry farming or under irrigation. Plowing under a light crop of peas in Wyoming increased the potato crop thirty-one dollars per acre. Potato ground is usually in fine condition for any following crop.

POTATO MACHINERY

Potatoes may be grown without the use of special machinery, but if any acreage is raised, it is economy to have the best equipment. There are a number of planters on the market. Some of the different makes are the Robins, Aspenwall, Superior, Evans and Excelsior. Digging may be done with a potato plow, which has fingers behind, which are worked by a shaker, or with the larger machines, like the Doudon or Brown. The potatoes may be sorted by hand when picked up, or all picked into a basket and run over a wire screen sorter. Where the potato beetles are troublesome, it is necessary to have some form of spraying machine to treat with Paris green.

HARVESTING AND SORTING

Potatoes are usually left in the ground some time after frost has killed the vines in the fall. This helps to ripen and dry out the tubers. They should be harvested before the ground begins to freeze. Where the potatoes are green, care should be exercised in handling and a sorter should not be used. If they are to go to market

at once they are sorted and sacked in two bushel sacks. If they are to be held for a short time and a root cellar has not been prepared, they may be pitted in the field. Do not dig deep pits, but smooth off the ground, put the potatoes in as steep a pile as possible, cover first with straw or vines and then with enough soil to prevent injury by frost. Leave a small space at top of pile not covered with the soil for the escape of



Plate XXXVII. A Good Potato Crop.

the heat and moisture given off by piled potatoes. Potatoes stored in this way will keep until the weather gets quite cold. Where root cellars are used, the potatoes are usually piled in loose, and kept as cool as may be without danger of freezing.

MARKET DEMANDS

Often our potatoes grow to very large size, single tubers weighing five and six pounds not being uncommon. These very large potatoes are not desired in the market. The best sale is

found for a medium-sized potato which will give from sixty to seventy-five potatoes per bushel of sixty pounds. Such potatoes are desired by hotel and restaurant-keepers for baking purposes. The farmer who properly grades his produce will always find ready demand and good prices. Uniformity in size and color, freedom from scab, crack or dirt, shallow eyes and pleasing shape are essential to secure top prices for the product.

CHAPTER XIII.

THE SUGAR BEET AND ITS CULTURE.

The luxuries of yesterday become the necessities of tomorrow. The main business of the farmer is to supply the world's necessities.

BEETS A DIRECT FOOD

Sugar beets may be grown for two general purposes; 1st, as a direct food for stock and man; 2nd, for the manufacture of sugar. Beets have been grown many years for stock feed, but the sugar beet for manufacture becomes a new crop, where factories are established.

The value of the beet as a supplementary food for stock is something we have been slow to learn. Even after the sugar has been extracted, what remains is worth enough for food to make the by-products valuable.

SPECIAL CULTURE REQUIRED

Where beets are properly raised for the production of sugar, their culture differs at almost every point from the culture of alfalfa, wheat and potatoes, which have been our staple crops.

The high sugar content and purity of the sugar beet are artificial characteristics produced by years of special cultivation, selection and plant breeding. This has given rise to "kinks" in beet culture, which are not only important but essential if we make the value of the crop suffi-

cient to meet the expense of producing it and provide a profit.

**BEET
GROWING
INTENSIVE**

Raising sugar beets is intensive farming. They cannot be successfully produced except by intensive methods. On this account sugar beet culture introduced into a community which has generally practiced extensive cropping, means learning something new. The farmer must put aside the idea that his experience with other crops will enable him to grow sugar beets successfully. He must follow the experience of those who have long practiced beet culture if he hopes for success.

The German who said that the Americans could not grow sugar beets because they would not get down on their knees to hoe, has given us some idea of the essential difference between beet culture and the culture of our ordinary crops. While there is a right method of beet culture, undoubtedly general practice may be somewhat modified by the peculiar conditions of each locality. Experience in other places is valuable, but not always infallible.

**ADAPTING
CROPS
IMPORTANT**

We have much to gain by creating races and varieties of plants which will be fully at home and adapted to our soil, climate and system of irrigation. It has taken long years of careful breeding and cultivation to produce the sugar beet of today. The amount of sugar it contains

has been quadrupled and other solids eliminated until it has great purity. At the same time the beet has taken on desirable shape and size. To grow them properly the farmer must carefully, honestly and persistently follow out rules of beet culture, perhaps with some intelligent modification.



Plate XXXVIII. A Perfect Shaped Sugar Beet.

It will probably take thoughtful farmers three years to learn to grow beets. You may make a good profit before you learn how to grow the beets, but your profit will not be as large as after a little experience.

**AVERAGE
CROPS NOT
PROFITABLE**

An average crop of anything is not highly profitable. The man who gets only an average crop should be well satisfied if he makes expenses, and should rejoice over an additional 3 per cent. gain on his investment. The average crop of potatoes for the United States is about 64 bushels per acre, say 38 sacks. In our best potato districts under irrigation the cost of raising an acre of potatoes is about \$30.00. There are not many farmers in the West who would go into their fields rejoicing, to harvest less than 38 sacks of potatoes per acre.

If the crop of sugar beets averages only 10 tons per acre, worth an average of \$4.50 per ton, there may or may not be a cash profit in raising them. It will depend on whether it has cost \$30 or \$50 to grow and market the beets. Good farmers in beet-raising sections will probably produce more than twenty tons and possibly twice that in some cases with little increase in the cost. Where this occurs they will bring magnificent profits and boom the bank account.

The main idea is, of course, the immediate money value of the crop. While this part of the reward will, undoubtedly, be highly pleasing to the man who properly grows his beets, it is not the only thing to be gained from beet farming.

**BEETS AND
PROSPERITY**

Where sugar beets are grown for a factory, producing them, more than the raising of almost any other crop, brings prosperity to a commun-

ity. This is not due alone to the money reward to the grower. There are several ways in which growing beets differs from the growing of other crops in the ultimate result to our agriculture.

**MONEY PUT
INTO
CIRCULATION**

First—The more money handled in a way which puts it into wide circulation, in any business, the greater is the commercial and social activity. This is the reason that manufacturing and trade centers are prosperous. Growing beets requires intensive cultivation. If a farmer raises 10 acres of sugar beets as they should be managed, it means the expenditure of \$300 to \$500, much of which is paid for labor. In a beet-growing community everyone is employed, everyone has some money to spend, and real estate, the merchant, the barber, the church and the school respond to the magic. The establishment of successful factories have always resulted in improved conditions.

**SOMETHING
TO BE
LEARNED**

Second—There is an important educational feature about growing beets. The farmer who raises them learns something new about agriculture. Some of the underlying principles of his high calling are forcibly brought to mind. He has known in a general way that plants are sensitive to conditions of soil and climate. He has read Mark Twain's way of putting it, when he makes Puddin' Head Wilson say: "Training is everything; the peach was once a bitter almond,

and the cauliflower is nothing but cabbage with a college education."

He is now becoming acquainted with a sugar beet which was once an annual weed growing on the seacoast, and the things he learns are too numerous to mention.

**PROFIT FROM
SMALLER
AREAS**

The bringing of some of this land under intensive cultivation to gain larger profits from smaller areas is a most important lesson for the irrigation farmer. We will have more people, more happiness and more general prosperity when we have fully reached the realization that more of everything we work for can be obtained from an irrigated farm of twenty acres properly managed than from an hundred or a thousand acres which keeps a man both skin poor and peniless. This is one of the last and hardest lessons the arid land farmer, who comes from regions where the more land the more wealth principle prevails, has to learn.

**GROWING
BEETS
IMPROVES
LAND**

Third—The continual stirring of the soil by the plowing, sub-soiling, planting, thinning hoeing, irrigating, cultivating and harvesting, improves the land. Jethro Tull, in England, taught that thorough tillage was the only thing necessary to make the soil everlastingly productive, and he was not far wrong, especially when the principle is applied to arid soil, containing as it does, practically all the plant foods that were in

the rocks from which it was formed, instead of having had its nutritious salts washed into the sea. This stirring of the soil saves moisture and does numerous other things to improve the land. It could hardly be better prepared for the support of any crop we may wish to grow on it. I know of no better clean culture crop for a rotation, than the sugar beet.

**RAISING
DIVERSITY
OF CROPS
ADVISEABLE**

Fourth—Growing sugar beets adds a crop to those usually produced on a farm. It does not take the place of other crops, but adds a new one. Diversifying the crop does many things for the farmer. He uses his land and employs his labor to better advantage. If he has several crops and one fails he can better afford to stand the loss, as there are others which secure an income.

**SUGAR BOTH
A LUXURY
AND A
NECESSITY**

Fifth—There is usually more money made by producing luxuries than anything else. Sugar is both a concentrated food and one of our greatest luxuries. The people of England use one-third more sugar per capita than the people in the United States. A few years ago an estimate was made that it would require 700 additional factories to supply our demand, and that demand is continually increasing. It seems that there can be no possible danger of glutting the market.

**BEETS WILL
GROW ON
ALKALI
LAND**

Sixth—Finally, sugar beets fill a niche in our farming not filled by any other crop. They belong to a family of plants which rejoice in

salty soils and will grow on our alkali lands. Farmers generally in irrigated regions know what it is to see portions of the farm becoming less productive through the rise of alkali to the surface. I know of no valuable crop, unless it is English Rape, which will grow in as strong alkali as will the sugar beet. Nor does the common, white alkali of this region injure the beets in any way, except that these salts may retard or prevent the germination of the seed. If such land is to be planted to beets the surface should have the salts washed out so that they will not be in concentrated form around the seed. Flooding water over the land will wash off the surface salt or dilute it and carry it back into the soil. Then the application of a dressing of manure to mix with the surface soil will help the land, prevent the rapid rise of salt again and enable the seeds to properly germinate. After the plants become well established the salts will do no harm if the soil can be kept in a good state of tilth.

**SUGAR BEET
CULTURE**

The land for sugar beets should be prepared in the fall. After the season's crop is removed, manure should be applied at the rate of ten to thirty loads per acre, the amount depending upon how green and strong it is. Manure from the sheep corrals is of the best for this purpose. We are not afraid of getting the ground too rich, but the danger lies in getting it too porous, thus allowing it to dry out quickly, especially in the

FERTILIZING

early spring. The manure should be plowed under in the fall if possible, even if the ground is very dry. It is better to sharpen the plow share for each acre and get the land plowed deep, eight to twelve inches is best, but if the ground has previously been plowed five or six inches, not more than two inches of the under soil should be turned to the surface, because it is poor in vegetable matter and fertility, so the young beet will not get an early start and vigorous growth.

PLOWING**IRRIGATING
LAND**

After the ground is plowed and harrowed, it should, if possible, be irrigated in the fall. The moisture left in the ground from this irrigation will be sufficient to germinate the seed the following spring. The ground will be pulverized by the frost and when harrowed in the spring will be in the best condition for the reception of the seed. The ground should be leveled so it may be easily irrigated. The work done in getting the ground in the best possible condition is profitably spent. No amount of work afterwards will make up for the lack of care in this.

**HARROWING
LAND****ROLLING**

Some roll the ground before, and some after seeding. This is usually a detriment to the crop. The harrow marks should be left in the field. The soil is generally left loose on top and evaporation is prevented by this earth mulch. The spring winds will not gather up the sand and fine particles of earth and slide them along the

surface of the ground, cutting off the young beets, as they do when the ground has been flooded or when it has been rolled. When the last harrowing is done, drive so the harrow runs cross-ways of the prevailing direction of the spring winds.

**USE CLEAN
GROUND**

Before planting your seeds be sure that the ground is free from sticks and all trash; go around with a wagon and pick this trash off. It will catch in your cultivator and before you can stop you have lost several feet in a row of beets. The damage is done. You have lost money. Alfalfa roots are like leather on your horse hoes. They will not be cut in two, but drag out and destroy the young plants. If you use alfalfa ground for your beets, plow the alfalfa as shallow as possible and still get all the roots cut. Follow with the harrow, harrowing out all roots and cart them off the land. RepLOW the ground three or four inches deeper than the first plowing and prepare the same as other ground. Alfalfa ground, fresh from the sod, produces fine beets, rich in sugar.

**TIME TO
PLANT**

Beets should be planted early. Plant as soon as danger of freezing weather is over. A frost will not injure the young beets, but a freeze so hard that the ground is frozen one-fourth inch or more deep will kill the beets. The beets should be out of the ground and as far along as

any of the weeds when it is time for the cultivator to start. The early planted beet gets a good start and shades the ground before hot weather begins.

SEEDING

The seed should be sown with the regular sugar beet drills, in drills 18 to 20 inches apart, and 1 inch to 1½ inches in depth. Spacing the rows 16 inches and 24 inches apart in order to furrow and irrigate between the wider alternate rows is a convenience on level ground where it can be applied.

These drills sow four rows at once and have two small wheels following each shoe of the drill, one on either side, and about one inch from the center of the shoe. These firm the soil about the seed and tend to bring the moisture to it, insuring an early germination. The beet seed requires considerable moisture before it will start, and it should never lack for moisture from the time it begins growth until the crop is "laid by" in August. The seed should be sown at the rate of 20 pounds per acre. It is poor economy to try to save seed. This amount of seed will produce many more plants than are desired, but it insures plants over the entire length of the row, which, when thinned, should result in a nearly perfect stand.

If a crust has formed over the ground from rain or irrigation, each seed which grows will help the others, and all working together will

push hard enough to break the crust so that the plants may get through. The importance of a good thick stand of beets cannot be over-estimated. In this lies the profit. It costs no more to grow, and little more to harvest, a crop of 30 tons per acre than it does a crop of 10 tons. The one crop yields a profit of \$60 to \$70 per acre, the other but pays the rent of the land and cost of growing.

**IRRIGATING
SEED**

If the ground is dry when the beets are planted, don't wait long for a rain, but turn on the water. The beets will be coming up in ten days or two weeks. The soil is likely to bake if irrigated, but you can follow by another irrigation, or if the plants are up so the rows can be seen, start the cultivator and use the horse "hoes" and "duck feet," or the "spiders," running the hoes as close to the rows as possible.

**HARROWING
BEETS**

Some practice harrowing to break the crust. This should never be done lengthwise of the row, for a harrow tooth getting in the row will drag out the beets for several feet. Harrowing is a bad practice; it injures the stand and kills beets in many places where it is desirable that they should grow. Don't harrow your beets, use the cultivator.

THINNING

When the plants show four to six leaves the thinning should begin. The quicker the farmer



Plate XXXIX. Boys Thinning Beets.

From *Agricola Aridus*.

gets this done the better for his crop. The beets are first spaced. This is done with a five or six inch hoe, the man striking the hoe so it will cut off the beets an inch below the surface, leaving two inches of the row of beets between each hoe mark. The spacing must be done quickly. A good man will keep on a slow walk, a mile an hour, and space as he goes. It does not pay to strike the hoe twice in the same place. Keep a file handy and have the hoe sharp. Files and hoes are cheaper than labor. After a few rows are spaced, the spacer learns to strike the hoe in the row wherever desired. The spacer is followed by thinners. Pull out all but one beet, disturbing the beet left in the ground as little as possible. Leave the beets seven or eight inches apart in the row. Some now advise leaving the beets 10 or 12 inches apart in the rows. It is not wise to leave more than one beet in a place, as the two, if left, will not equal in weight a single beet alone, and it is quicker at harvest time to top a single large beet than two small ones. In pulling the beets be sure to get them out by the root. If the tops are pulled off, they will grow again and your labor has been done in vain. A good spry man will space and thin an acre in three days. It takes most men four days or more.

CULTIVATION

The cultivator should be started as soon as the rows can be seen, using the "hoes" and "duck

feet." Early cultivation kills all weeds in sight, as well as great numbers that have germinated, but are still under the surface. The cultivator attachments should be kept sharp. A large weed will catch on a dull tool and drag out the beets. The beets should be cultivated every ten days or two weeks until the leaves cover the ground. When the leaves get so large they are injured by the cultivator, the cultivation must cease. In cultivating, use a slow, steady horse, and for the first two cultivations have some one lead the horse. The eyes of the man who has hold of the cultivator handles must be on the beets. The cultivator takes two rows at once. It is important to get started on the rows right, for the drill has sown the four rows parallel with each other, each row of the four has the same crook in it, and in cultivating but one row of beets needs watching; if that row goes all right past the cultivator, the other row being parallel, is sure to. If you start in on the fourth and fifth rows with your cultivator you will find yourself in trouble. They are not exactly parallel and you are sure to destroy parts of one or both. In setting the "hoes," bring them as close together as possible, without destroying the beets. It is better to have the hoes for the first two rows a little too far apart to give the operator some experience and skill in cultivating.

HOEING

After thinning, the cultivator should be kept going. At intervals of ten days or two weeks

the beets should receive two thorough hoeings. A small five-inch hoe should be used, which can be run between the plants the same as in spacing, killing all the weeds and loosening the soil about the beets. In this work the young beets should not be cut or scratched with the hoe. Such cuts do not heal properly and the beets are injured for life. If the ground is not too foul, the second hoeing will subdue the weeds, the beets will be well started and a harvest in sight.

IRRIGATION OF BEETS

When the beets need water, give it to them. Don't think they must be thirsty so the roots will go after moisture and get deep into the ground. They will go down, anyway, if the ground is not too hard. The most of the root feeders are near the surface and here is where most of the nourishment is obtained. Beets are like alfalfa in that they go deep after plant food. They stand neglect better than most crops and will do much to redeem themselves if given good after-treatment, but it is unprofitable to allow the growth to become stunted for lack of water. There are two irrigating shovel attachments for the best cultivators, which make furrows between the rows of beets. These should be used before irrigation is commenced, but the soil should not be thrown up on the beets. When the beets are thus covered, the yield is much less. The furrows allow the water to follow along between the rows and when run from three to five hours it has soaked to the

beet, the moisture is below the surface and the soil does not bake next to the beets. It is not best to flood beets. The beets when flooded tend to be smaller in size, but are generally richer in sugar. The water standing on them in hot weather is likely to scald and kill them. It is best to follow each irrigation with a cultivation, as soon as the ground is dry enough.

Irrigation should be given as often as the ground becomes dry. Never allow the beets to suffer for water. The sugar beet is a crop that will pay for all extra work and attention given it. It is these extra attentions that give profit in beet culture.

RIPENING

It is in September and October that the beet makes the best growth, the leaves contract along the midrib and veins, the lower leaves take a yellowish cast, the beet is now making sugar fast. Beets that would yield about 15 per cent. sugar the first of October will yield about 18 per cent. October thirty-first. In this extra per cent. is a good profit. The manufacturers will usually wish to start the factory early and will want early beets to begin on. The early planted beets will be rich in sugar, but even these are still making sugar.

HARVESTING

When the beets are ready in the fall, they are dug with a beet plow, drawn by three or four horses. This plow runs by the side of a row and

lifts the beets in the soil, cutting or breaking off the root. The beets are then pulled and thrown into convenient piles, sixteen to twenty rows are generally thrown together in this manner. The beets are topped with corn knives, or a special beet knife with a blade ten inches long. The beet is taken in one hand, the top cut off with a single stroke, and then thrown into the pile. With good help it will cost 50 cents a ton to do this. It is important that the beet be topped quickly and the "topper" should be quick and hit the beet at the desired point hard enough to sever the top. When topped the piles are thrown together and covered with the tops to prevent evaporation of the juice and as a protection from frost.

**CARE OF
TOPS**

The top of the beet is cut off about midway between the mark of the lower leaf and the crown of the beet. The beet leaves should be placed in small piles, two feet high by about two feet broad, and left in the field to cure. When cured they are hauled in and fed to cattle and sheep. They are liked by cows, and containing so much of the tops of the beets, are a valuable feed. If the tops are hauled in and put in large piles before they are cured, fermentation begins and a smoking, hot, rotten pile is soon the result.

**COST AND
PROFIT**

The expense of growing an acre of beets may be estimated as follows, the farmer allowing him-

self wages and a little more than cost of feed for his team :

Manuring, 15 loads at 20c.....	\$ 3.00
Plowing	1.25
Harrowing .....	.25
Leveling .....	.75
Planting .....	.50
Seed, 20 lbs. at 15c.....	3.00
Thinning	6.00
Hoeings	6.00
Cultivating and furrowing, 6 times at 50c	3.00
Irrigating, 6 times at 50c.....	3.00
Pulling, topping, hauling, for a yield of 15 tons per acre at \$1.00.....	15.00
	<hr/>
	\$41.75

FEEDING VALUE

Horses, when they have learned to eat beets, are very fond of them. The hair becomes glossy and coat slick when beets form a portion of their feed. Milch cows do well on them. Steers get fat when fed beets. Hogs relish them and will fatten rapidly. If fed a small grain ration with beets the hogs do better than when fed grain alone. Sheep will fatten fast on beets and corn. They are considered cheaper feed than corn, and the mixture cheapens that ration. Chickens will

pick into beets and consume them as they will melons. The beet tops have become an important feed in cattle and sheep fattening.



Plate XL. A Colorado Sugar Factory.

CHAPTER XIV.

MISCELLANEOUS CROPS.

Variety is the spice of life, and the farmer need not carry all his eggs in one basket.

FLAX

Writers have usually admitted that flax is a much neglected crop. It is becoming more and more appreciated in the West. It is one of the most drouth-resistant plants, resists hail well, will grow in a short season and, where there is sufficient early moisture to stimulate the first growth, it will usually make a crop. The main difficulty in raising flax in the West has been that of finding a market, as there are no mills for the extraction of the oil and the linen industry has not called for the fibre. However, we have made some new discoveries in regard to the value of flax seed for feeding stock. Early feeders failed to get good results with flax because they fed too heavily, upsetting the digestion of the animals and causing urinary troubles. With more moderate feeding, flax has found a place in Western farming.

FLAX CULTURE

Under irrigation, flax does not stand much water. It should be irrigated lightly and never flooded too long.

Average yields are fifteen to eighteen bushels per acre; but maximum yields of twenty-eight

bushels have been known. Sixteen bushels per acre have been grown at altitudes of over seven thousand feet, and flax from that locality took a medal at the Chicago World's Fair. If cut early enough, often a second growth will spring up, which is valuable for fall feed. If raised for the grain, sow twenty pounds or twenty-five pounds of seed per acre. Where grown for flax fibre, it should be planted thick, using forty or fifty pounds of seed. Sow with a grain press drill, planting one-half inch or one inch deep. Cut when the majority of the seed balls are light brown in color and when the straw is somewhat green. If left too long, it shatters badly in the field. It is best harvested with a self-rake or binder, without the binding attachment. A small amount of flax may be sown with oats and the crop cut and fed in the straw or threshed and fed as mixed grain. Some experiments in Wyoming resulted in very fat lambs by feeding ground flax seed, turnips and alfalfa hay. Seventeen to twenty pounds of seed fed in this manner in a period of ninety to one hundred days made the lambs fat without any other grain. From two to four ounces of seed per day in connection with other food is sufficient for a sheep. Small amounts of flax seed fed to horses with grain give good results, especially in the spring.

BUCKWHEAT

Buckwheat is one of the very valuable dry farm and short-season crops for the West. It

can be planted as late as July, where our seasons are long, and planted in the spring at our higher altitudes will usually mature a good crop. It is one of the easier grain crops to grow, and is of much value as stock feed, where there are no mills for making buckwheat flour. The principal use made of it is for chickens, but when ground it makes a good grain for other kinds of animals. It will usually do on soils which have been plowed early or on sod. For dry farming plant about twenty pounds of seed per acre, and twenty-five or thirty pounds where plenty of water may be had for irrigation.

There are two principal varieties, the Japanese and the Silver Hull. The Silver Hull produces a smaller grain than the other, but we prefer it for general planting. Buckwheat should not be allowed to get too ripe before harvested and must be handled carefully in our dry climate to prevent shattering.

BEANS

Beans are one of the best paying dry-farm crops, as they will mature with comparatively little moisture. Large areas are devoted to bean culture in California, where the season is long enough to mature lima varieties. Beans are a cultivated crop which fits into Western farming. They are legumes which gather nitrogen from the air and improve the soil. The best varieties for field culture are the large Navy or the small Navy, the Mexican bean, and Red

and White wax. They should be planted in rows two and one half feet apart, sowing two to three inches deep, so the seed will be from three to four inches apart in the rows. This will take from twenty pounds of small kinds to sixty pounds of seed per acre. The culture of the bean is simple and easy. A deep mellow seed bed should be prepared and the crop should be cultivated often until the time of bloom. Where irrigated, the water should be sparingly used and never allowed to reach the crowns of the plants, and cultivation should follow each irrigation. Do not work beans when the plants are wet with dew or rain. Watch for and kill the bean beetle. (See chapter on insect enemies.) They must be harvested by pulling with dump rake, but it will usually be found advisable to pull by hand, as the crop is valuable and should not be lost by hurried methods, which will shatter the beans.

ROOT CROPS

Every farmer with stock to feed should grow root crops to supply winter succulence. In the West there are few places where making silage will pay. In a dry country, however, some succulent food is most valuable. Root crops are not grown for the amount of food material they contain, so much as to supply a variety of feed and to help the animals digest other foods given. Turnips are most usually raised, and it costs very little to produce the crop. They may be

sown as a catch crop, with the corn the first of July, or planted on other land and drilled or broadcasted. Use two to four pounds of seed per acre, and keep the ground as moist as possible without making it too wet. The best varieties are the White egg and Golden ball, for our higher altitudes, Purple tops, and Swedes, or Rutabagas for general planting.

Mangels are the easiest beets to grow. They do not require thinning and special culture required by sugar beets. Mangels contain so much water and so little dry matter that they are one of the poorest root crops for feed. However, they produce large yields, and are worth while in many localities. The half sugar mangels are the best form of stock beets to grow. They contain enough sugar to make their feeding value higher than the mangel. Of mangels or half sugar beets, use eight to twelve pounds of seed per acre, and sow in drills two and one-half to three feet apart. They may be irrigated and cultivated like the sugar beet.

PASTURING BEETS

A method of harvesting root crops which has long been in vogue in England is becoming popular in the West. This is to pasture them with sheep or hogs. The English farmer uses hurdles, pasturing small areas at a time. After the animals eat the tops of the roots down into the ground as far as they can reach, the farmer pulls out the lower parts of the roots with an iron hook

and knocks off the soil or loose roots with a coarse knife. These partly-eaten roots are fed to stock hogs.

It has been thought that our winters were too cold for this kind of stock feeding, but our falls are usually open, and considerable time is available for the pasturing of root crops before freezing weather gets too severe.

**JERUSALEM
ARTICHOKE**

The artichoke is the most hardy tuber grown. It may be grown far north and left in the ground over winter. Its principal use is as feed for swine and it is especially valuable in pig pastures for brood sows which get a good amount of exercise in rooting out the tubers. This is one of the plants which give the largest yield of food per acre. Yields have been known of over seven hundred bushels of artichokes per acre. This tuber is made considerable use of as human food. It is usually sliced and eaten raw in salt and vinegar, but in Europe it is often boiled or otherwise prepared like potatoes.

The artichoke is a tuberous rooted sunflower and ordinarily only the tubers are valuable, though sometimes where grown thickly on the ground, the tops are cut and cured for forage. It may be left in the soil year after year without replanting. When this is done, to prevent the plants getting so thick that they crowd each other, they are cultivated, leaving strips of plants about three feet apart one way and a foot and

one-half or two feet apart in the rows, by cross-cultivation. The cultivation is done when the artichokes begin to grow in the spring, and are four or five inches high. We have known crops to be produced year after year where the rainfall was only ten inches and the season short and cold, and this was done without any special care or irrigation.

Many are afraid to plant artichokes because they consider them a bad weed. It is not difficult to destroy them as weeds. They are allowed to grow a foot or two high before being plowed. Then planting the land to wheat or other grain and giving it cultivation with the harrow and weeder will entirely rid the soil of artichokes in one season.

The culture of artichokes is the same as that for potatoes, though the cultivation may be less frequent and more shallow. They are planted in rows three feet apart, and may be put in with a potato planter or dropped by hand in furrows and covered with a plow or harrow. They should be planted from three to six inches deep and the tuber may be either planted whole, which is the method pursued if the planting is done in the fall, or they may cut one or two eyes to the piece when planted in the spring. They may be harvested like potatoes and stored and fed, but their greatest use is in the pig pasture.

CHAPTER XV.

PLANT BREEDING.

Ignorance of the Laws of Nature Make up the Mysteries of Life.

HISTORY OF PLANT BREEDING

All material and mental progress hinges on man's ability to wrest from nature more than he needs for mere subsistence. It depends primarily on his ability to apply and use natural forces. Perhaps I may carry the thought a step further and say that true wealth and true advancement depend, not so much on the abundance of raw material, as on our ability to work changes in that material which make it contribute to our happiness and contentment.

Never before were the minds of men so keen. Certainly there is no evidence that our forebears could make the intelligent use of natural forces that men are accomplishing today. This advancement is apparent in all lines of productive industry. It is through the more or less intelligent guidance of man that the vital laws of plant and animal change and improvement enable a less number of tillers of the soil to supply the basic support which allows other forms of civilized activity to proceed. Time was when man must use all his effort to procure necessary food alone. Afterward raiment was added as the first luxury, only to become a fixed neces-

sity. This was followed by all the variety of other things which men could exist without. At



Plate XLI. Wheat Breeding by the Author.

1. Common Form of Turkey Red Winter Wheat.
2. Improved Turkey Wheat.
3. A New Beardless Winter Wheat—Scale at Left.

the present time not only the mere necessities, but the luxuries as well, are actually supplied to the world by one-third of the working population who are producers.

**IMPROVE-
MENT BY
DOMESTICA-
TION**

Until very recent times, indeed, agricultural progress has been slow. As a rule, all life that man has brought under domestication for his use has been improved over its wild state. The one exception (and it takes one exception to prove the rule) seems to be the donkey, which an Egyptian writer tells us has deteriorated much from the character of the wild ass of Africa, from which it sprung. Until the present day, the improvement in our best developed breeds of animals has not been as great as might be expected, and seems to have depended more on an abundance of food than on breeding proper. The profound changes which have occurred in plants have no parallel in the animal kingdom. The simple reason for this seems to center in the difference of mere productiveness of plants and animals, and in the fact that plants may be propagated by vegetative parts, so that their perpetuation does not depend on two parents and two lines of mixed heredity. The principles of life of development and growth, of variation and change, are the same in both plants and animals, but breeders can observe the lives of a vast number of plants compared with a limited number of animals. Some of the most prolific animals, like certain fishes and insects, have been little subject to artificial breeding. The birds which have been domesticated are the most prolific and show the greatest variety, and improvement, evi-

denced by the numerous breeds of fowls and pigeons, but outside of these there are probably none which will bring forth more than twenty fold in a year.

**DISCOVERY
OF SEX IN
PLANTS**

The underlying principles of any kind of breeding have been known to man but a few years. Sex in plants was known to the ancients, and the doctrine that plants are of different sexes seems to have been entertained even among the original Greeks. Several Greek writers divide plants into male and female, but as Loudon points out, their conception was based on erroneous observations of habit, and the significance of sex was not understood. The real discovery of sex in plants seems to have been made by Cameraria in the last years of the sixteenth century, but Bailey states that "The true significance of sex in plants was first clearly conceived by Hofmeister in 1840."

**PLANT
BREEDING
IS NEW**

We have no indications in ancient writing of true plant breeding. In the parable of the sower is this sentence, "And they fell on good ground and did yield fruit and spring up and increased and brought forth some fifty and some sixty and some an hundred fold." It is probable that the productiveness of plants in earlier times was supposed to be due entirely to the productiveness of the soil, and to outside conditions,

rather than to any inherent qualities in the plants themselves. It is true that artificial selection was carried on by Roman farmers, perhaps as early as the beginning of the Christian era. Virgil, in his poem *Georgics* (1-197), as translated by DeVries, says:

“The chosen seed through years and labor improved,
Was seen to run back, unless yearly
Man selected by hand the largest and fullest of ears.”

He says further, “elsewhere Virgil, and some lines of Columella and Varro, go to prove in the same way that selection was applied by the Romans to their cereals, and that it was absolutely necessary to keep their races pure.” DeVries goes on to show how nearly all crops were then, as they are now, composed of mixed varieties. The mixed condition was known, but men had no distinct ideas of either specific marks or variety differences, and many of the elementary forms have entirely disappeared. Bailey states that there are one hundred cultivated varieties of plants, the primitive ancestors of which cannot be certainly traced. This is a large per cent. of the whole, as DeCandolle recognizes but two hundred and forty-eight cultivated species.

**PLANTS
NATURALLY
ADAPT
THEMSELVES**

Adaptation to environment and natural selection has made profound changes in plants. This is evidenced both by cultural varieties, which have improved under domestication without any special attempt on the part of man to make them better, and, as well, by the fact that every climatic region displays true character in its vegetation, due to the plants having adapted themselves to conditions. Nature alone has shortened the season of certain plants, so they can reproduce themselves in the colder climate; has reduced the leaf surfaces and thickened the epidermis that species may be enured to drought; changed the sensitiveness of plants to the effects of frost or heat; and has done many other things to produce the marked variations found in plant communities of different regions.

**EFFECT OF
CLIMATE**

In the Michigan Agricultural Report for 1880, Dr. W. J. Beal states that he found that field corn becomes marked with dents in three years when taken from Michigan to Kansas. On the contrary, at Lansing, Michigan, dent corn has a tendency to ripen earlier and become rounded at the tip of the kernel, from year to year, unless care is taken to select seed to perpetuate the dent character. A statement is made in Encyclopedia Britannica that "A single ear of precocious rice has given rise to the only kind that can now be grown north of the Great Wall in China." These statements have reference to

natural accidental changes rather than to improvements by men through the use of plant breeding.

**EARLY
PLANT
BREEDERS**

While the great impetus to plant breeding dates back only to the publication of Darwin's "Origin of Species," in 1859, some breeders had done considerable work over one hundred years previous to that. Most of this work consisted of selection only, to separate out, or pedigree the elementary species which had originated accidentally, probably through mutations, or "sports" arising in ordinary farm culture. A few of the more important names are those of Von Mons, who began to experiment in 1785, and in 1823 had 20,000 seedling trees in his "Nursery of Fidelity," in Holland. He gave his attention almost wholly to pears, and created important new varieties of fruit. Professor Bailey has given Von Mons credit for being the earliest apostle for selection and amelioration of plants.

Another early explorer in the field of plant breeding was Joseph Cooper of New Jersey, who in 1799 called attention to the fact that "Change of seed is not necessary to prevent degeneracy." He originated the Cooper plum and some other plants of importance. At the same time, Andrew Knight, in England, took up studies to determine the best means to improve plants. In 1806 he wrote: "New varieties of every species

of fruit will generally be better obtained by introducing the farina of one variety of fruit into the blossom of another than by propagating any form from a single kind" (Bailey, "Survival of the Unlike"). Perhaps at even an earlier time than any of the dates mentioned, about the middle of the last century, Louis Vilmorin discovered the principle of selection for improving plants. DeVries says that he was the first to apply this principle to plants. His work is classic in the improvement of sugar beets. He did his work, not by crossing or breeding proper, but by selection of those beets which showed the greatest specific gravity due to sugar. Toward the last of the century, also, Maryano Lagasca of Spain published some papers dealing with this subject, and he interested Colonel LeConteur in the Island of Jersey, and LeConteur produced some valuable new varieties of wheat. Thus we have in the last of the eighteenth century and the first part of the nineteenth century the beginning of plant breeding almost contemporaneously in Holland, England, France, Spain, and the United States.

Fifty years ago some of the principal breeders of cereals were Sheriff of Hadington Hall, Scotland, and Hallet of England, who produced pedigreed wheats; Rimpau of Germany, who has worked principally on rye; Risler of Switzerland, and Farrar of Australia, who were breeders of wheat.

**BREEDERS
OF THE
PRESENT
DAY**

In the last two decades a few of the greater plant breeders merit special notice. While there are a number who have produced numerous varieties of merit, more especially in parts of Europe, the men who have given the subject profound attention are: Hugo DeVries, the great Dutch breeder; Mendel, the discoverer of Mendel's law; Luther Burbank, who has done more than any other man in the improvement of plants and the creation of entirely new things; Professor Nilson of Svalof, Sweden; W. M. Hays, who developed new improved varieties of wheat in Minnesota; and L. H. Bailey of Cornell, who has written much to popularize the subject. Numerous other men have done important work along this line, most of it being incidental to other activities, or consisting of more or less accidental discoveries. Among these were Professor Blount, who developed new wheats in Colorado; Robert Gauss, who has been working with dry land wheats at Denver; Professor Holden, who has improved corn in Iowa; Burpee of Philadelphia, who originated improved beans and sweet peas; Peter Henderson of New York, in the same kind of floral work, and others.

**WHAT PLANT
BREEDING IS**

The principles of breeding need not be touched upon at this time. It is not complicated to one who has given it much study; in fact, Bailey states, in answering the question,

"What is the mystery of plant breeding?" only this: "Good care, varying circumstances, and judicious selection for what you want." Of course this covers the subject of cross pollenization and other means of artificially inducing variation, observation, and judgment to discover useful characters, ability to take advantage of mutations, and arranging circumstances to supply plants with the internal necessities and the external comforts. The value of the work is untold, nor can it be estimated. We can hardly make statements so extravagant that they would be untrue. Our agricultural interests are so vast that their commercial importance far excels any other industry.

**VALUE OF
PLANT
BREEDING**

The influence of plant improvement on the welfare of man is most profound and far-reaching. One can hardly imagine what our condition of life would be if we should suddenly become dependent on wild animals and undomesticated plants. The subject bears a deeper significance than one of mere subsistence, for the very refinements of our minds are, without doubt, more intimately associated with all the influences of a tamed environment. Would not civilization itself, a result of domestication, be partially obliterated if we were deprived of the society of improved forms of other kinds of life? Who will attempt to compare the ethical effect of our everyday use, and association with a

highly cultivated rose or a wild one, a juicy, delicately flavored, seedless orange, or a small, bitter, wild crab apple, a loaf of white bread made of improved wheat, or the rough cake of barley bread, including the bran and husk, a diet of experimentally bred and fed lamb or the coarse, rough flesh of the wild boar?

In one of his papers, W. M. Hays says: "As the breeding of sugar beets is worth to the world tens of millions of dollars, so the breeding of cereal, forage, fibre, and fruit crops will be worth many billions." Mr. Hays himself produced a prolific wheat in Minnesota, which increased the agricultural wealth of that State by an estimated ten millions of dollars per year. A few years of corn breeding in Illinois, Iowa and Missouri has doubled the corn crop of those States, and the money values are so vast that if stated the mind could not grasp their significance. It has been a well recognized fact that highly specialized plants like the sugar beets, or pedigreed grains, can only be kept from deteriorating by continual selection, and on this account their seeds are not generally produced by the mass of growers. Seed raising and general plant improvement has become a specialized business, and the general farmer must continually renew his seed from the best sources to meet with success. Every improvement is of unmeasured value to the producer and to the commonwealth.

**NEED OF
PLANT
BREEDING**

As a rule, plant breeders have given special attention to improvements which appeal to the aesthetic and artistic. They work in horticulture, making more beautiful trees and shrubs and flowers, or developing new fruits. Comparatively little has been done in this country, and that in recent years, to improve the great staple crops of the farm. Nearly all of our improved varieties of grains have come from the Old World. In the Middle States corn breeding has brought about remarkable increase in crop yields and values. On the Atlantic and Pacific seaboards much effective work has been done in creating and adapting new varieties of fruits and vegetables. But in our great arid America, where irrigation farming is developing so rapidly, and dry farming is now receiving so much attention, outside of one or two Experiment Stations, there has been little or no consecutive effort put forth either to improve our crops or to adapt those kinds and varieties most suitable to our new conditions. Nearly two decades ago Professor A. E. Blount put out some important improvements in grains. His No. 10 and No. 16 wheats were widely grown and his rust-proof oats gave him a world-wide reputation. For some years past Mr. Robert Gauss of Denver has been doing most interesting and valuable dry-farm wheat breeding. Alfalfa, the king of crops for the West, and fast becoming a queen among crops for the East and South, has not yet been

moulded into more prolific and better forms for our farms. Oats and wheat are not staple in



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Plate XLII. Breeding Black Winter Emmer.

1. Parent Type.
2. A Sporting Type.
3. A Beardless "Sport."

Bred by the Author.

this region, but new varieties introduced from regions with soils and climate unlike our own continually "run out," and are replaced with some new importation. We have no established sort of barley, and the rye grown in the West is poor, compared with some of the magnificent sorts bred by the Germans for special kinds of soil and other conditions. Our farmers need heavy yielding, disease-resistant varieties of potatoes. Our stockmen need better grasses and more suitable feeding stuffs, and everybody needs better shade trees and adapted fruits and garden vegetables.

**PLANTS MUST
BE IMPROVED
FOR EACH
REGION**

We cannot have these improvements unless they are developed at home. We must improve our own alfalfa, grasses and other forage. An improved variety of grain or other vegetable created in Europe, or in the tropics, or in a rainfall region, may produce one or more good crops, but many of them are unprofitable and perhaps none of them will hold when planted here year after year, unless adapted by selection and plant breeding. At the same time, seeds produced under our peculiar conditions of soil and climate are superior. At our high altitudes, where the seasons are short and cool we should produce many hardy, quick-maturing and valuable sorts of farm and garden crops. The principle is becoming well established that the most successful seeds and plants are those which are produced in

a region where the conditions of soil and climate are as unfavorable and trying as those in which the crops are to be grown. A few years of careful plant breeding will undoubtedly produce results of untold value to the whole arid region. Our farm lands are vast in extent and the ranch and farm interests are so great that a small increase in yield or a small improvement in quality in the aggregate becomes worth many millions to the country.

**WHAT THE
FARMER
CAN DO**

Plant breeding in the scientific sense is not practicable work for the farmer. He may do much to keep up the high quality of his crops by careful attention to seed selection. If he raises seed of any crop for his own use he may keep it pure by weeding out all plants or varieties which would contaminate or mix his seed. He may obtain small quantities of promising new varieties and increase the seed by the best methods. He may select the seed he expects to save from the best parts of the field or from the best potato or corn hills. Though he may not establish new varieties, he may prevent much running out and keep up a high standard of quality and quantity. This kind of plant-breeding work is profitable for every farmer. He should especially be on the watch for new improvements which have been secured under conditions of soil and climate similar to his own.

Part V.

CROP DESTROYERS.

*There are beasts of field—birds of air
And insects humming everywhere
Which, as we take their native store,
Depend on us for more and more.
They with us share the food we spare,
To eat our store their only care.
But man is king, Divine command
Gives him rule of earth thru the mind and hand.*

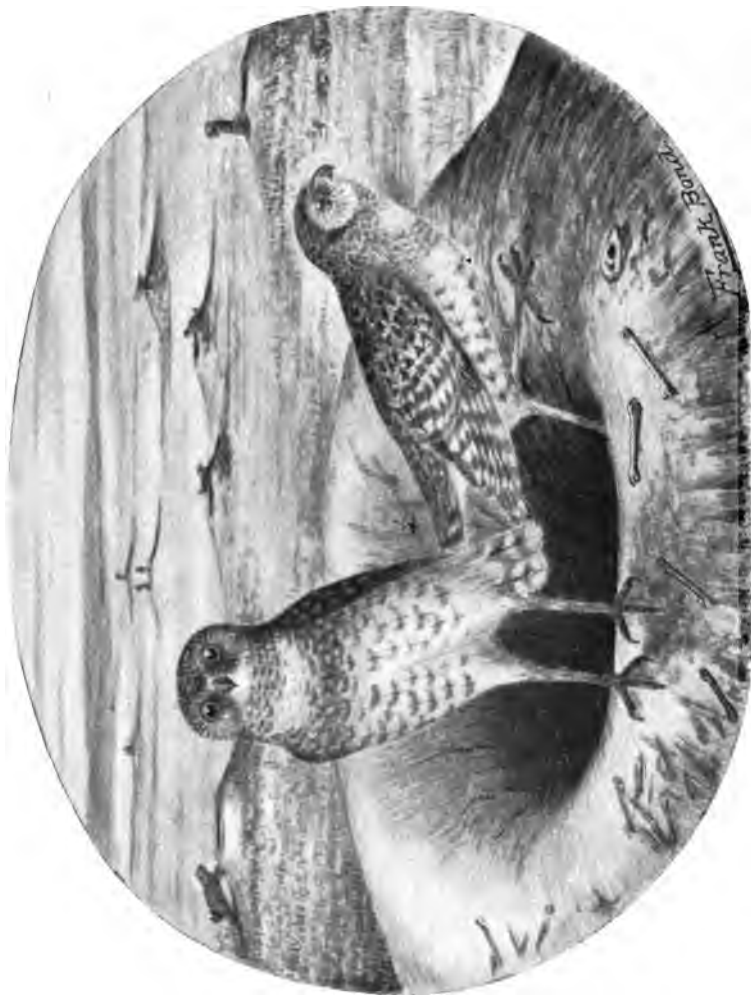


Plate XLIII. A Good Use for Prairie-Dog Holes. Do Not Harm the Owls, But Exterminate the Dogs. By Permission University of Wyoming.

CHAPTER XVI.

WEEDS.

Weeds are not altogether useless. They make us till where we might neglect to till, and keep our minds at work to devise a better husbandry.

WHEAT WEEDS DO

A weed is a plant that grows where it is not wanted. Weeds quickly take advantage of the negligent farmer, but, as a rule, they do not worry the man that knows how. On the irrigated alfalfa farm weed control is more perfect and easy than in any other place of which we know. Notwithstanding this, every farmer has his weed problems, and it often occurs that a quick and prompt use of knowledge will save loss and future worry.

Weeds occupy soil that should be occupied by more useful plants. They starve, dwarf and kill or make unprofitable our money-making crop. Weeds use up plant food and, what is more important to us, they are just so many pumps taking moisture out of the soil and throwing it away. Plant-food used by weeds may be restored to the soil if the weeds are not removed, but the moisture used by them is irretrievably lost.

Unightly and troublesome weeds knock down farm values, for intelligent buyers of land pass by a weedy farm that otherwise would be

most desirable. Weeds make the poor farmer a nuisance to the whole community, for his crop of weeds is a blighting pest sent to do his neighbor harm. If a farmer choose an unprofitable husbandry, it is his own folly; but if that system harms his friends, he should be summarily dealt with in proportion to the offense. A quarantine against weeds, especially where we have winds and running irrigation water to facilitate their spread, is as reasonable as any other quarantine. Some weeds poison our animals or ourselves. The milk weed, known as "Snow on the mountain," a native of parts of the West, is very poisonous to some persons, causing serious skin disease by simply touching it. Its beauty has caused this weed to be planted and picked for bouquets; but people should understand its nature and be on their guard. Almost every one is familiar with the effect produced by the poison sumac, poison ivy, or poison oak. Sometimes people attempt to eat weeds they know nothing about, like strange toad stools or the wild peas which grow on astragalus plants in the West, and if they happen to live, they always have something to look back upon with regret. The principal weeds that poison live stock are discussed in Part VI, of this book.

Some weeds are parasitic and injure or destroy crop plants by living off their sap. It would not be out of place to call the lower forms of plants, which produce certain plant and ani-

mal diseases, weeds. Of the parasitic flowering plants we need only speak of one, the dodder, or "Love vine," of alfalfa.

Weeds may cause direct injury to our live stock, as the western squirrel tail grass, known everywhere as "Fox tail," which gives animals that eat the heads sore mouths. There are numerous burrs which injure wool by their presence. Some weed seeds adulterate our crops, always lowering their value and often making them worse than valueless for seed again. Weeds often harbor insects or make hiding places for rodents that are a real menace to the farmer's crop. The Colorado potato beetle was a native, feeding on the Buffalo burr; but when potatoes were planted, their tender leaves were more to his taste and he became one of the greatest farm pests. Mustard plants carry plant lice through the winter, so they are ready to take to our cabbages and rutabagas as soon as we try to grow a few for ourselves.

As one of the worst things that could happen, Job said, "Let thistles grow instead of wheat, and cockle instead of barley." We shall never be able entirely to get rid of weeds, but they are worthy of the farmer's steel. "Weeds, like the poor, we always have with us. * * * As shiftlessness causes poverty and poverty induces shiftlessness, so shiftlessness induces weeds and weeds cause poverty now, just as they did in the time of Solomon." (Aven Nelson.) A great

majority of weeds are killed by the cultivator, the disc, the drag harrow, and the hoe; but some of our worst weeds may be more profitably gotten rid of by special methods. Alfalfa is the greatest and most effectual weed eradicator of the West.

**KILLING
WEEDS
WITH
SPRAYS**

Spraying weeds with solutions of sulphate of iron (copperas) or common salt, is a comparatively new way of destroying them. The sulphate of iron treatment is being strongly advocated by companies who get this material as a by-product in their manufacturing, and are seeking a market for it. There is merit in this method of killing certain weeds if properly done, and the conditions are such as warrant the expense. The secret of success seems to be the use of power sprays or hand spray pumps which throw a very fine spray with considerable force. Some weeds may be killed with other chemicals. A Montana man has invented a dandelion exterminator, which consists of a tube with which gasoline is placed in small amount at the roots of these pests. Where weeds occupy ground that is not desired for raising crops, like railroad rights of way, sprinkling with crude petroleum is used both to kill the weeds and lay the dust.

How to mix and use sprays is given under the weeds for which they are useful. The following dozen worst weeds of the West, with their treatment, will give general information which

can be applied to practically any weed problem that may arise. Sweet clover is left out of the list because we consider it one of the desirable weeds. There are places where it is troublesome in dry farming, but as it is a biennial, simply keeping it from going to seed for two seasons will entirely destroy it. There are many weeds like Buffalo burr, rag weed, cow weed, pig weed, lamb's quarters, sunflowers, etc., that must simply be given the hoe or other clean culture.

DODDER

Dodder is called "love vine" by many. It is a yellowish or brown, fine stemmed parasitic plant with bunches of whitish flowers. It grows on alfalfa and other small stemmed plants. The small stems twine themselves around the alfalfa and send little roots into the tissues for their food supply. In places where alfalfa does not make the strongest growth the dodder may entirely kill the plants. Alfalfa seed often contains dodder, but there is no excuse for this or for the farmer planting it. Dodder seed is only about half the size of alfalfa seed and may be removed by screening through a screen with twenty meshes to the inch and blowing to remove any unthreshed seed heads of the dodder.

If dodder appears in the field, it may be destroyed by mowing close to the ground, before the dodder blooms, and removing the crop. If the dodder has produced seed, it may be killed by mowing and burning the crop on the ground.

Should the soil become infested with dodder seed, the best method is to plow up the alfalfa and cultivate some large stemmed crop on the ground for two years. The dodder seed germinate in the ground and throw up stems which twine around the alfalfa, the connection with the ground dying as soon as the plant becomes established as a parasite. The plant only lives one year and must come from new seed in the ground each season. The thorough spring discing advised for alfalfa, if done at the right time, will effectually rid the field of dodder. The right time is after the dodder seed have germinated and before the little plants have attached themselves to the alfalfa.

IRON WEED

We do not know that the common name, "Iron Weed," is the one always applied to the plant here discussed. This is known to botanists as *Franseria discolor*, and under the new arrangement of names it has been changed to *Gaetnaria*. The weed is a small plant somewhat resembling western poverty weed. It is a perennial, living for an indefinite length of time, and is one of the most difficult weeds to kill with which we have to do. It crowds out all cultivated plants and seems to come up from the roots an indefinite number of times when attempts are made to kill it by cultivation. After it becomes established, it covers the ground with a mat. The plants are five or six inches high and there is

a small slender spike on the top, which looks something like rag weed. The leaves have a whitish green appearance. It is probable that the best method of destroying iron weed is deep and continuous cultivation. It usually occurs in comparatively small patches and it is possible that a very strong spray of sulphate of iron or salt might help destroy it.

DANDELION

The common introduced dandelion is one of the worst weeds of the West. In places it takes possession of lawns and will entirely run out any of the lawn grasses. Sometimes it occupies fields and at our high altitudes it seems to compete successfully with alfalfa. Many attempts have been made to discover some means of competing with the dandelion. For many years writers made the recommendation that the dandelion should be dug out with a chisel or "spud." It has been shown that a dandelion root cut off below the crown year after year simply branches and throws out more numerous crowns. If the dandelion is cut off below the crown and some solution like strong brine, kerosene, or sulphate of iron is injected into the hole to kill the root, it may be successfully killed. Our recommendation for lawns is to plant grass seed so thick, on ground that has been cultivated until it is entirely free from weeds, that there will be as little room as possible for the growth of dandelions. Then, if the land can be irrigated by sub-irriga-

tion from below, or by an occasional thorough and deep soaking with water by flooding instead of by the ordinary method of sprinkling on the surface, the seeds of the dandelion blowing or falling onto the sod will not be so apt to germinate and become established. Spraying with sulphate of iron solution is often recommended. It will kill off the tops of dandelions without serious injury to the lawn grass, but unless it is repeatedly done, which takes considerable expense, it will not be successful. The strength of sulphate of iron recommended for dandelions is two pounds to each gallon of water. Dandelions in the field may be killed by plowing and putting into cultivated crop for one or more seasons or by thorough summer tillage without crop. In the long run it does not pay for any one to wear himself or herself out digging dandelions out of lawns. A good heavy seeding of grass on well prepared ground to secure a perfect lawn will usually remain looking well for eight or ten years. When the dandelions get thick enough to get unsightly, plow or spade up the lawn, giving the soil clean culture and such treatment as will germinate all weed seeds in it until the first of July and replant with blue grass and white clover. You can use as much as 150 pounds of blue grass seed and thirty pounds of white clover seed per acre.

WILD OATS

It is commonly believed that tame oats degenerate and change to wild ones. This is no

more possible than it would be for a Shorthorn cow to change to a Jersey. Wild oats do seem to come very mysteriously sometimes, but they accumulate in the soil unnoticed until they get serious enough to be a pest. Growing alfalfa, rotation of crops and clean culture are the only successful remedies.

BIND WEED

This is a wild or vine Buckwheat. It is one of the worst western weeds in grain fields. Care should be taken to plant seed which does not contain this weed. The seeds are small, three-cornered and black or dark colored. Clean culture is the remedy. Using a weeder in the grain field until the plants are a foot or more high will kill most of the buckwheat.

**CANADA
THISTLE**

The Canada thistle is a perennial thistle which is one of the most persistent and difficult weeds to kill. It has been introduced into some parts of the arid region, but usually occurs in small patches only. Where there are only small spots of thistle, the suggestion has been made that the hay and straw be stacked over them. The plants may be killed by digging out root and branch. It is said that sprinkling with common salt solution, one-third barrel of salt to fifty-two gallons of water, will kill it. This will probably kill anything else that it is applied to as well; but it will pay to stop the spread of these thistles, even at sacrifice of the crop. The plants should never be allowed to go to seed.

COCKLE

All farmers are acquainted with the pink blossoms of cockle in their grain fields and with the round, black seeds in their threshed grain. The amount of damage done by cockle is very great. We have heard a good word for cockle from one man, who fattened his stock on the ground seed. Nothing has been published regarding the feeding value of cockle seed, but it may be worth investigating. Cockle is easily killed by clean culture. The great difficulty is that unclean seed is so often planted. It should be watched and killed down in waste places and on the borders of fields.

**PRICKLY
LETTUCE**

The wild or prickly lettuce is one of the most common and one of the worst introduced annual weeds. It is closely related to the cultivated lettuce, but has prickles on the smaller leaves. These plants have the habit of twisting their leaves so that the edges point north and south. It is one of the most unsightly winter weeds in fence corners and along road sides. It produces a large amount of seed that is distributed by the wind and irrigation water. Clean culture is the remedy. It does no good to mow this weed as its branches freely from any part of the stem left above ground when it is cut off and will ripen seeds in a remarkably short time.

**FOX TAIL
OR WILD
BARLEY**

The squirrel tail grass, commonly called Fox Tail in the West, is one of our very worst weeds.

The young plants are good feed for stock, but as soon as the heads are formed, it becomes dangerous on account of the beards. It spreads in many native meadows or in alfalfa fields, and mixed with the hay, it does great damage to stock which eat it.

A general condition which favors fox tail is over-irrigation, especially in alfalfa or native meadows. It is an annual grass, ordinarily living only one year, where it is unmolested, and forms its regular crop of seeds and beards. When it is cut, however, it undoubtedly lives more than one year. This fact and its habit of forming heads right at or close to the ground when the tops are cut off, or when there is drouth or poor soil (a habit of the barleys) makes fox tail difficult to exterminate. It may be killed out of alfalfa by proper cultivation and discing as we recommend. Plow up meadows and plant some other crop that will take the place of fox tail. We have cleared badly infested fox tail land by planting sweet clover or dwarf rape for one or two seasons.

CRAB GRASS

Crab grass, or barnyard millet, or wild Japanese millet, is a persistent weed in cultivated fields and along ditches. It seems to grow either under great drouth conditions or under water, as the case may be. Like most other weeds belonging to the grass tribe, it must be hoed or cultivated out.

**RUSSIAN
THISTLE**

Russian thistle is now common everywhere and is known to everybody. It is a weed which seldom grows anywhere but in cultivated ground or that which has been dug up at some time. Russian thistle was at one time the subject of many scare articles by those who believed it would ruin agriculture over large areas. It does much damage on poorly cultivated farms, especially in the semi-arid sections where grain-growing predominates. Its principal damage in irrigated sections is in the tumble weeds filling ditches and clogging flumes. The Russian thistle is not a bad weed to cope with. It matures late and there is a long season in which the farmer can kill it by cultivation. Once cutting off the plant below the crown kills it. It seems that after Russian thistles have grown a few years in a waste section of land they disappear for some unknown reason. Many think that Russian thistle makes good fodder, but we have better forage in the arid region. It is not a thistle at all, but a true tumble weed, belonging to the goosefoot or lamb's quarter family.

**POVERTY
WEED**

Poverty weed occurs in many western soils. It is usually found in land of poor tilth, containing more or less clay. This is a small weed, growing from a few inches to a foot high. It has a rough, sticky feel, a strong odor and bears little flower heads hanging in the axils of the leaves. Poverty weed is a perennial and multi-

plies by underground root stalks, so plowing or cutting off the plants simply thickens them. One of the best remedies is to manure and work the soil to bring it into a good state of tilth. Poverty weed does not like such civilized agriculture and disappears.

MUSTARD

There are a number of forms of mustard which occur as weeds. They are annual plants and include, ordinarily, wild mustard, shepherd's purse, pepper grass, and the tame black and yellow introduced mustards. These weeds become detrimental to crops of grain and flax and do much damage in such crops as alfalfa seed. Mustard seed cannot be cleaned out of alfalfa seed by any ordinary means, and while mustard seldom becomes troublesome in alfalfa which is cut for hay, the seed containing it never brings the price of pure seed. The same statement is good for sweet clover or other adulterants of alfalfa seed. It will pay the alfalfa seed-raiser to go through his alfalfa and destroy such plants by hand. He should see to it that the threshing machine or huller which threshes his alfalfa does not contain mustard. Mustard seed may be screened out of grains, but it is difficult to get all of it.

THE SULPHATE OF IRON SPRAY FOR MUSTARD

Mustard is one of the weeds that may be successfully killed with sulphate of iron spray. The weeds should be treated when they have from four to eight leaves, or as soon as they stand a

little higher than the young grain. The spray is most effective if applied when there is a little dew on the plants, but should not be used in rainy weather. The strength of the solution is 100 pounds of iron sulphate to 52 gallons of water. Stir to dissolve and strain through cheese-cloth so it will not clog the spray nozzle. This makes enough solution for one acre. Apply with a force spray pump. Where this is used to kill the weeds, it turns some of the grain leaves brown or black and puts back the growth of the grain crop a few days.

CHAPTER XVII.

INSECT ENEMIES.

Man has some competition for the world's supply of organic food. He must overcome his insect competitors.

WHAT ARE INSECTS

Insects are small animals which have six legs; bodies often almost cut in two and made up of segments or rings; heads with feelers and two to half a dozen eyes; mouth parts for chewing, sucking or lapping their food. To those who have not studied the scientific classification, all insects are bugs and to the popular mind, practically all bugs are bad. Insects eat the same kind of foods that are necessary to other animals and man. There are a few which are useful to the farmers. Honey bees are the most intelligent of all livestock, for they live in organized communities and not only gather the raw material but manufacture it into a finished product ready for the use of man. Some insects aid the farmer by destroying other kinds which do damage to his crops. These are called predaceous or parasitic, as the case may be, and such friends should be fostered. Some of the useful ones are the ground beetles, tiger beetles, ladybirds, ant-lions, aphid-lions, mosquito hawks and parasitic insects, which destroy countless numbers that would otherwise eat our crops. In some places there are "lady birds," (small beetles)

that almost entirely destroy certain scale insects or the eggs of potato beetles, and other detrimental forms. Many insects serve a useful purpose in their relation to plants. They carry pollen, securing cross-fertilization and are indispensable to the perpetuation of some plants. Of the insects that lap their food there are none which are directly injurious to crops. It has been shown that such insects may carry disease from one plant to another or from many sources of infection to animals and man. The house fly seems to serve no useful purpose and does untold harm in spreading infectious diseases. The war on house flies should never cease. The butterflies and moths are not directly injurious, but their larva, the caterpillars, have biting mouths and are among the most destructive forms.

INSECTS THAT SUCK

The most destructive insects that suck their food are plant lice, scale insects, squash bugs, mosquitoes and biting flies. We have a great variety of plant lice often called the "green fly" or "brown fly" or the "green bug." We cannot feed these bugs anything that will kill them, because they stick their bills into their food and suck the juices. We must hit them from the outside. It may be done by killing the bug or its eggs in the winter stage, as by cleaning up all refuse like old cabbage stumps, etc., in the field or garden, or we may kill them by contact poisons. Insects breathe by means of small pores

or openings along the sides of the body. By clogging up these pores we smother them to death, or by using caustic solutions we may burn the life out of them. For such bugs, therefore, we use whale oil soap, or kerosene emulsion, or tobacco juice, or smoke, or gas, or fine dust, like Persian insect powder (Pyrethrum). For the larger sucking insects, like the squash bug, the most effectual method seems to be to hand pick and kill them with a club.

There are many sucking plant lice that live on the roots of plants and cannot be reached by sprays. Some of these, like the grape phylloxera and others may be killed by injecting bisulphide of carbon into the ground. The gas goes down thru the soil and kills the insects, but does not injure the plants. An effectual remedy for lice on tree roots is to work a few pounds of powdered tobacco into the surface soil around the tree, then wet it down. Tobacco juice will kill anything but man.

INSECTS THAT CHEW

There are great numbers of insects that destroy crops by simply eating them. Such insects as beetles, grasshoppers and caterpillars are examples.

Insects that chew their food may be destroyed with stomach poisons, at least where they live on the outside parts of plants. The poisons generally used are Paris green or arsenate of lead. Sometimes the poisons do not work or are

injurious to plants or dangerous to use, and other methods must be found.

**KEROSENE
EMULSION
FOR BUGS**

Kerosene Emulsion is made as follows: Dissolve one-half pound of hard soap in one gallon of soft boiling water. While the water is hot, mix with it two gallons of kerosene. Put in the kerosene and thoroughly churn the oil and soap together, until the substance is so mixed it is like soft cream. When ready to use mix one gallon of this emulsion with twenty-seven gallons of water, and spray it over the bugs with a spray pump or sprinkle it on them with a brush or broom. It should be used fresh and care should be taken not to spray the oil on plants after it has separated. This is used to kill many small insects, especially small sucking bugs, like plant lice.

**WHALE OIL
SOAP FOR
PLANT LICE**

A solution of one pound of whale oil soap in six or eight gallons of water will kill most plant lice if thoroughly sprayed on them. This solution may be used to wash house plants which are infected with scale insects. Apply to such plants with a tooth brush or other stiff brush which will remove the scales.

TOBACCO

Tobacco is deadly to plant lice. "Black leaf" may be purchased in bulk and diluted by mixing one gallon with seventy gallons of water and the solution used as a spray. Tobacco decoction is

made by steeping or boiling four pounds of tobacco stems or two pounds of tobacco dust for an hour with water enough to cover and then dilute to four gallons with water. It should be used when fresh.

**PARIS
GREEN AND
ARSENATE
OF LEAD**

There are a host of insects that feed on leaves or other exposed parts of plants that may be destroyed with stomach poison. The poisons usually employed are Paris green and arsenate of lead. Use one-half pound of Paris green to fifty gallons of water or two to three pounds of arsenate of lead to fifty gallons of water and spray the solution over the leaves upon which the insects are feeding. This is an effectual remedy for general use.

**HOW TO
DEAL WITH
SOME
COMMON
INSECTS**

There is much variation in the effect of both contact poisons and stomach poisons. The general rule laid down for their use will meet most of the insect problems with which the western farmer will have to deal. Some more complete or detailed treatment for a few of the more common and destructive insects will give practically all the information needed on the subject.

**GRASS-
HOPPERS**

The migratory grasshopper has not committed depredations for several years. There are local grasshoppers, however, which do need the farmer's attention in many farm regions. These grasshoppers are those which lay their eggs more

especially along the borders of alfalfa and other fields and sometimes get so numerous that they cause damage. They are called locusts by entomologists. The eggs hatch out early in the spring when there is green vegetation for the little hoppers to feed upon, and if food is plenty they do not wander very far from the place where they are hatched until they get considerable size. They may be destroyed in several ways. Plowing or harrowing, especially with the disc harrow late in fall or early in spring, will destroy the eggs, as they are quickly killed when exposed to air. In running the disc or rotary alfalfa harrow over alfalfa fields the road sides and ditch banks should also be harrowed on account of the grasshoppers and other insects which may be killed.

Grasshoppers may be quite effectually destroyed by the use of poisoned bran. Use three pounds of Paris green with one hundred pounds of bran and moisten with water which has been sweetened. Mix the dry poison and bran and moisten so it "crawls" and will scatter like seed when sown from the hand. One hundred pounds will go quite thoroughly over 25 or 30 acres of alfalfa or potato field. Mix in a tub and scatter from a buggy as you drive along. This is especially valuable in potato fields when grasshoppers are thick enough to do damage. This poison bran can be sown broadcast where the hoppers are most numerous. This is undoubtedly one of

the surest, best and cheapest of remedies. Professor Gillette, of Colorado, says that one of the simplest and often a very effectual remedy, is to grow plenty of chickens and turkeys to range over the infested fields. Poultry must be protected at night against coyotes and other animals. Where large fields are affected, hopperdozers may be used. Grasshoppers collected in this way may be sacked and pressed or dried and used as breakfast food for poultry.

**POTATO
BEETLES
AND BEET
BEETLES**

The Colorado potato beetle is common almost everywhere. At our high altitudes this beetle is sometimes effectually held in check by the "lady birds," which eat their eggs. Beet fields often suffer damage from the ravages of blister beetles and other leaf-eating insects. It is not difficult to destroy these insects by the prompt and thorough use of the Paris green or arsenate of lead sprays.

CUT WORMS

The cut worms are produced by night-flying moths and are most difficult to treat, because they hide in the top soil, more especially during the day. They generally feed at night. They may be killed by baits of poisoned bran made as we have suggested for grasshoppers. A trap crop may be used in the garden by planting radishes or other plants which cut worms like, between the regular crop rows. Good trap crops are young weeds which are eaten as well as other

plants by cut worms. Spray the trap crop with Paris green or arsenate of lead solution, or dust Paris green mixed with flour from a cheese cloth sack over the plants when the dew is on. The cut worms eating this poison will be destroyed before the regular crop comes up. A good method of protecting plants like cabbage or tomatoes from cut worms is to set a small cylinder of cardboard or tin around each one. A tin can with both ends melted off or a small piece of tin which is bent by rolling around a hoe handle, serves the purpose.

THE COTTONWOOD BORER

This borer causes much damage to young cottonwood and poplar trees. As it works under cover inside the trunk of a tree, it is difficult to reach. The method is to paint all places where the limbs have been cut off, or breaks in the bark with pine tar or white lead, take out the borers with a knife or wire and trap the moths when they are flying. Borers feed a year or so under the bark before they bore into the wood. Their presence is detected by dark spots in the bark. The most effectual remedy is to dig them out or with a syringe force a spoonful of fuma in the hole and plug it up.

BEAN BEETLES

In bean beetles we have an instance where the poison is more deadly to plants than it is to the insects feeding upon them. The bean beetle is a "spotted lady bird," the only one of the tribe,

so far as we know, that feeds on plants. Professor Gillette, of the Colorado Station, has been working to find an effectual means of destroying the bean beetle. The best method so far discovered seems to be the very simple one of knocking the beetles off the plants on to the ground, in the very hottest and brightest part of the day. The beetle has the habit of playing "possum." Feigning death—on the ground in the hot sun—really results in his committing suicide in a very few minutes. Few, if any of them, which do not fall in the shade, ever get back on the plants. Another method which is effective is to examine the under side of the leaves and pick off all those which have yellow patches of eggs on them.

PEA WEAVELS

The field pea is a highly valuable crop in much of the arid region and the pea weavel in some places is becoming common and quite destructive. One of the most efficient methods of getting rid of pea weavels in the field is to destroy all the vines which are left there at the end of the season. This may be done in the garden at least. The weavels may be destroyed in the peas by putting in a tight box and setting a small dish of fuma or bi-sulphide of carbon on top of the peas. Close the box for a few hours and the gas will go down through the seed, killing the live weavels or larva. Small amounts of seed may be kept in a tight box and the weavels will

come out before planting time, when they may be destroyed.

POTATO FLEA BEETLES

The potato flea beetle is doing much damage in some of the potato sections of the West. The larva of this beetle goes into the ground and feeds on the potato. They produce what is called "crack" and make unsightly burrows underneath the skin. The beetles which come from these larvae are little brown or black fellows which jump like the turnip flea beetle. The beetles feed on the potato leaves, making small holes in them. The question of destroying these beetles in potato fields seems to be one largely of rotation of crops. There are several forms which feed upon many other plants, more especially turnips, radishes, mustard and the like. They may be destroyed by the use of pyrethrum or Persian Insect Powder, put on the plants very early in the morning before sunrise, or they may be kept away from plants by sprinkling ashes, slacked lime or sulphur over them. A spray of bordeaux mixture will serve the same purpose.

CABBAGE WORMS

There are two forms of the cabbage worm which are very common in the West. One is a butterfly caterpillar and the other is the caterpillar of a moth. They may be destroyed, when the cabbages are small, by Paris green or arsenate sprays. Such sprays on the outside leaves

will do no damage and will not be dangerous later in the season.

**CABBAGE
LICE**

The lice which become so abundant on cabbage, cauliflower, mustard and like plants are quite difficult to combat. Kerosene emulsion does not effect them, because they are covered with powder which keeps the spray from wetting them. To be of use a spray must be applied with such force that it will knock the lice off the plants. A spray of hot water is sometimes effectual and the user can become so expert that he can use water hot enough to kill the lice without injuring the plants. A very fine forced spray of pure coal oil may do the work. The problems of dealing with such lice will have to be worked out by each grower.

**FALSE
CHINCH
BUGS**

The true chinch bug has never been destructive to crops under irrigation. There are places, however, where the false chinch bug, which looks very much like the ordinary form, becomes quite destructive. In places they destroy crops of beets and may attack many other crops. The kerosene emulsion spray is the only thing which has been suggested outside of crop management, and it may be said that there is no effective remedy.

**THE
WESTERN
ARMY
WORM**

These army worms appear at intervals and are so thick and ravenous that they destroy everything before them. Where army worms

are present, they winter in the larva or pupa stage, in the surface soil. They may be effectually destroyed by plowing or discing to turn the soil up to the air and cold. The worms may be killed with the stomach poisons used as spray.

HOUSE FLIES

We spoke of warring on the house fly. The principal method by which they are controlled is to rid the premises of horse manure or other offal as fast as it accumulates. Cleaning up their breeding places, if carefully followed out, will do much to mitigate this nuisance. The use of sulphate of iron in the manure when stables are cleaned has been suggested. Manure should not be allowed to accumulate but should go to the field as fast as made.

CLOVER SEED CHALSTS

This is a tiny insect belonging to the bee family. It deposits its eggs in the young seed of alfalfa, when it is forming. A tiny grub hatches from the egg and eats the inside out of the seed during its growth, simply leaving empty shells, which blow out when the seed is cleaned. This insect causes considerable loss to clover and alfalfa seed growers. Should it get serious enough in any locality to make seed growing unprofitable, it will be necessary to stop the seed production for a couple of years until the insect disappears.

WHY KILL THE ANTS

For many years ants were not classed as injurious insects. They do not directly eat farm

crops or useful plants, but we know now that they do other things which make them enemies to agriculture. The one useful thing which ants apparently do is to serve as an example of industry to the sluggard.

The western mound-building ant truly loves the desert. She builds mounds of small gravel and does not allow any vegetation to exist for some distance around her home. On the range and in new fields, before this ant becomes discouraged by cultivation and drowned by irrigation, she occupies much space that should be occupied with grass or crop. Each one carries a pair of scissors and industriously cuts off every sprouting grain or small plant as fast as it comes up.

Ants are destructive nuisances around dwellings or in yards. They will discourage or bother colonies of bees by robbing the hives of their honey. Another thing which ants do that causes incalculable damage is to harbor and foster plant lice. Plant lice excrete as foecal matter a sweet fluid called honey-dew. The ants are very fond of sweets and they actually rear and care for the plant lice in return for the food product. Some ants carry the plant lice eggs into their nests in the fall, give them careful storage thru the winter and in the spring place them on roots or tender shoots of plants where they can begin the business of supplying honey-dew to the ants as soon as they hatch. In other cases the ants care for

the living plant lice in their nests, putting them on crop roots and moving them to new pasture when the old is used up. It has been found that the corn root louse depends for its existence on a small brown ant and the way to destroy the louse is to make way with his ant friend who uses him as productive livestock.

HOW TO KILL ANTS

Ants, like bees, live in organized communities. At the head of each colony is one or more queens who keep up the supply by laying multitudes of eggs. On this account it is not possible to destroy a colony of ants by catching or killing the workers which are always running around looking for trouble. We must put something in the nest that will reach the queen. The best material for the purpose is bi-sulphide of carbon, or fuma. To destroy the nest put one or two ounces of fuma into the ground at the top, and around the nest, and cover with a sheet of paper and dirt. The gas will go down into the ground and kill everything it reaches. Bi-sulphide of carbon is explosive and if you light a cigarette when handling it you will probably not live to care whether the ants do damage or not.

THE EFFECT OF EARTH- WORMS

Because angleworms are usually found in rich soils or because Darwin wrote about how they had helped form new soils, many believe they are harmless or even useful. In some parts of the West angleworms get too numerous in the

soil. When a soil contains many of them it is injured. The earth worm eats soil and in passing thru them it is puddled. The tilth may be so completely destroyed that plants will not thrive. We have noted this in many lawns, some gardens and often in the case of house plants raised in flower pots.

**REMEDY FOR
EARTHWORMS**

Earth worms are easily destroyed. They are covered with a thin and soft skin which is quickly used up by the contact of lime water. Soil in flower pots and even on lawns or small gardens may be rid of worms by liberal application of lime water. Slack lime in a barrel and pour the clear lime water on the soil. It has no detrimental effect on growing plants and may be freely used.

CHAPTER XVIII.

PLANT DISEASES.

One plant devours another and the struggle for existence often resolves itself into a battle with bacteria.

NOT MUCH TROUBLE WITH PLANT DISEASES

Our agriculture in the West, with new soils and arid climate, is comparatively free from serious trouble with plant diseases. As farming increases and the soils have been in cultivation for some time, many of them used year after year for the production of the same crop and no attention given to the first appearance of sickness in plants, these diseases sometimes steal upon us unawares until they occasion heavy loss. Usually they are not considered worthy of serious thought until heavy loss has occurred and the disease is practically beyond control. The farmer must be on the lookout for all those things which seem detrimental to his prosperity. The plant diseases of the West, like other conditions which we find, are different from those of the East, where agriculture has been practiced for many years. Ofttimes a disease appearing in the West is attributed to the same cause which produces a like disease in the East, and nearly as often the observer who studies deeply, finds that he has been mistaken. There are a few men in Western colleges and experiment stations who are now studying plant disease problems.

Some of these men believe the diseases we have that seem common to other places, are new and typical of our own agriculture. As an example, it has been stated that the potato scab of the West, which scientists and writers have considered identical with that of the East, is not the same disease, but is produced by an entirely different fungus. Our potato blight is a *Western potato blight*, probably due to the same fungus which produces dry rot, and not to the fungus which produces the late blight of the East.

These considerations and the new discoveries indicate that, even with our plant diseases, we must unlearn the old and learn the new. We must build up our own knowledge of agriculture and take nothing for granted because it appears to be so from what we have known in other countries.

There are diseases of grain, such as rusts, for which there is no effective treatment. Rusts do not affect grains to any extent in the dry region, and careful irrigation may prevent damage from them. With many diseases the solution will be the breeding of disease-resistant strains. The cantaloupe blight has been effectually controlled by breeding disease-resistant strains of seed. We are now working to control the leaf-spot disease of alfalfa.

There is one great, ever-present, and destructive

disease of potatoes which causes incalculable

losses. This disease is due to a fungus known as *Rhizoctonia*. It appears in various forms, and receives different names, according to the way it strikes. Common names for it are "Root Rot," "Little Potatoes," "Big Vines and Little Potatoes," "Collar Rot," and "Blight," and Professor Paddock informs me it is the cause of most of the Western potato scab. This fungus lives through the winter, either in the soil or in the resting stage (*sclerotia*) on the potatoes themselves. The disease can be recognized by anyone who knows what to look for. It appears as spots of brown or black on the outside of the potato. These spots may be from the size of a pin point to a quarter inch in diameter, and they stick very tight to the potato skin. They look like particles of black soil. Seed potatoes with much of this disease on them should not be planted, or if they must be planted, they should be sunburned, as suggested in our chapter on potatoes. The principle remedy for this disease, as stated by Professors Paddock and Bennett, is to plant on "potato soil." They class as potato soil those loams which are well underdrained, or alfalfa sod upon which experience shows that potatoes will grow. There are certain regions in the West where potato culture fails on account of *Rhizoctonia*, and with our present knowledge such areas can not be made to produce sure and heavy crops of potatoes.

**WESTERN
POTATO
BLIGHT**

As stated above, this blight is due to a different fungus from that which produces the blight of the East. It is probably due to the same fungus that produces the dry rot of tubers in the cellar. As this fungus works inside the plant, it cannot be reached with sprays.

It has been thought that this Western blight of the potato could be prevented or cured by spraying; but the new light thrown on the cause of our blight by Professor Paddock and his assistants in Colorado shows it to be a disease for which no remedy has been discovered. The only suggestion made is that the seed may be cared for in a way which will help prevent the blight. Potato cellars should be kept sanitary and well ventilated, and be thoroughly cleaned out and fumigated. Crop rotation is indicated, and one of the best remedies for potato troubles seems to be to always plant after alfalfa sod, and not follow potatoes with potatoes on the same soil.

Some security may be had by dusting the freshly cut potatoes for seed with air-slaked lime, or flowers of sulphur.

**DISEASES OF
SUGAR BEETS**

The *Rhizoctonia* of the potato lives on a number of different hosts, such as peas, alfalfa, sugar beets and other things. It does considerable damage in places to sugar beets. Rotation of crops is the indicated remedy. Where it occurs never follow beets with beets.

**LEAF-SPOT
OF BEETS**

The leaf-spot comes on the outside leaves of the beet and travels inward, killing one ring after another, causing the center stem to grow tall. It causes loss by producing poor beets. Leaf-spot can be prevented by spraying with Bordeaux mixture, but spraying is seldom resorted to.

**CURLY TOP
OF BEETS**

This disease has been destructive in some places. Professor Ball, of Utah, finds curly top is due to injury to the leaf by the punctures of leaf hoppers. Anything which will kill these little bugs will cure the disease. Leaf hoppers suck their food and can only be killed by contact poisons like kerosene emulsion, tobacco sheep dip, or pyrethrum. Rotation of crops and winter tillage of the soil would also be effective.

**BACTERIAL
DISEASE OF
SQUASH**

In some seasons bacterial disease will destroy entire fields of squash vines, more especially the Hubbard squash. It attacks the plant at the crown and the first notice of it is usually when the whole plant suddenly wilts. The disease may be spread from one plant to another by squash bugs or other insects which puncture the plants and carry the germs from one to the other. There is no known remedy for this disease except to pull and destroy at once any plants which go down. It may be possible to stop the spread of the disease to other plants in this way. Usually killing the squash bugs will prevent its spread.

**CROWN
GALL**

The crown gall is a disease of trees. It produces galls or warty growths on the roots, more especially near the crown of the tree. Crown gall has long been recognized as a dangerous and troublesome disease for which there is no known remedy. We call attention to it here to warn those who plant trees not to plant any upon which crown gall is present, but to destroy them at once. Our horticultural laws are strict to prevent the introduction of crown gall, but occasionally an affected tree will escape the notice of the inspector, and if one is found it should never be planted.

**LEAF-SPOT
OF ALFALFA**

Leaf-spot of alfalfa is comparatively a new disease in the West, but it is one which is rapidly spreading and doing much serious damage. It usually appears in late summer in the form of small brown or black spots on the leaves and stems. The leaves soon curl up, turn yellow, die and fall off, leaving the lower parts of the stems bare. It is a fungus which saps the vitality of the plant, destroys its growth, lowers the yield and prevents the production of seed. In some fields the entire stand has been destroyed. Three remedies have been suggested. One is the early cutting of the plant and removing it before it gets too dry in order to prevent the shattering off of the leaves. This takes away most of the spores of the disease. Another is to cut the hay, let it remain on the ground until it is thoroughly dry

and then burn it to destroy the fungus spores. The third remedy is the production of a disease-resistant variety.

SOME NEW ALFALFA DISEASES

In Colorado a bacterial blight of alfalfa has made its appearance. When this disease has infested a field the results are bad. It is usually indicated by a poor first cutting of hay. When the blight gets down to the tap root it kills out the entire plant. No remedy is yet known for it. In Kansas a red root rot is reported on alfalfa, that works in circles, killing the plant as it travels through the soil. This again seems to be due to *Rhizoctonia*. Another root rot which works on cotton is reported from the Southwest on alfalfa. There is a rust affecting alfalfa, but it does not seem to cause serious loss. The downy mildew which is noticed as large yellow or white areas on the upper sides of the leaves, occurs during wet weather, but the damage from it is not great. No doubt other diseases may appear from time to time. In nearly all these diseases of alfalfa the plowing of the field and planting some other crop is a general recommendation to be carried out, or checking the disease by cultivation to aerate the soil.

BORDEAUX MIXTURE

Bordeaux mixture is a fungicide which is more commonly used than any other for the treatment of all those plant diseases which are caused by fungi that grow on the exposed parts

of plants, such as blights, mildew and leaf-spot. It is made by dissolving four pounds of blue stone (copper sulphate) in a gallon or so of hot water. Slack four pounds of good quick-lime in another gallon of water. Then dilute each solution separately to twenty-two and one-half gallons. Pour the dilute sulphate and quick-lime solutions together and thoroughly mix. This makes forty-five gallons of mixture ready to spray. Sometimes there is more or less precipitate and the mixture should be strained to remove any particles which might clog up the spray nozzle. It is applied as a fine spray with any good spray pump. Copper sulphate should never be dissolved in vessels of metal. Bordeaux mixture should be used while it is fresh, as it does not keep well for any length of time. Often where there are both plant diseases and insects the Bordeaux mixture is made into a stomach poison by adding one pound of Paris green or two pounds of arsenate of lead to the above amount of spray.

GRAIN SMUTS

Grain smuts are known to all farmers, and we need not describe them. Smut affects wheat, oats and barley, and the treatment for all these grain troubles is the same. For corn smut there is no remedy except to prevent the soil from becoming contaminated by cutting out and destroying the smut as soon as it appears.

**TREATMENT
OF SMUT**

As smut causes very much damage and is an easily preventable disease, it is simply the farmer's negligence if he does not avoid any loss from this source. Probably the easiest and one of the most effectual treatments to prevent smut is the use of blue-stone. Farmers object to a method which requires long soaking of the grain. A quick way commonly used is to put three teacups full of blue-stone in half a barrel of water and dip the grain for fifteen minutes. The sprinkling of grain with the copper sulphate solution, as recommended for formalin, has proved effectual. If the grain is badly smutted, and using it can not be avoided, the following treatment will be sure: Dissolve one pound of copper sulphate in 24 gallons of water. This is best done by putting the sulphate in a gunny sack and hanging it in the top of the barrel or other vessel containing the water. After it is all dissolved, soak the grain for twelve hours. At the end of the time take out and drain. Then place for fifteen minutes in lime water made by slacking one pound of lime in ten gallons of water.

**FORMALIN
FOR SMUT**

Formalin, or formaldehyde, is sold at the drug stores in about forty per cent. strength. Mix one pound of formalin in forty gallons of water. Spread the grain on a clean floor or canvas and with a sprinkling pot or spray pump, sprinkle the grain with the formalin solution,

shoveling it over until all of it is thoroughly moistened. This amount of formalin will treat from a ton to a ton and one-half of grain. After treating, put the grain in a pile and cover with old sacks or canvas for two or three hours. Then spread it out where the air will dry it as quickly as possible. If this treatment is carefully done, it is effectual, but care must be taken not to get the solution too strong or it will injure the germination of the grain.

**HOT WATER
TREATMENT**

The Jensen hot water treatment is often used. The things which recommend it are: it is effective if properly done; it is non-poisonous and causes the grain to germinate more quickly than any other treatment. The method consists in soaking the grain for ten minutes in water, which is kept at a temperature of 132 degrees to 134 degrees Fahrenheit.

CHAPTER XIX.

RODENTS AND BIRDS.

The farmer must love his enemies with effectual, death-dealing dope, but he should recognize, protect and foster his friends.

**THE ARID
REGION IS
NATURALLY
FULL OF
LIFE**

Our country of so-called little vegetation supports a remarkably varied plant and animal life. It is not generally known, but is true, that in some States of the West, botanists have classified and put on record more kinds of plants than are found in humid, Eastern States. Bird life is varied and abundant, and there are surprising numbers and kinds of small animals and insects. A country favorable to other kinds of organic life is favorable to man. The farmer must have dominion and to do so he must at times cope with enemies which would destroy his profits or share his crops without compensation. The class of animals most destructive is the small, furbearing gnawers, or rodents. Among them he must deal with gophers, ground squirrels and prairie-dogs, chipmunks, moles, mice and rats, skunks, weasels, badgers and rabbits. The irrigator is bothered with beavers and muskrats.

Toads, frogs, lizards and snakes (except the rattler) are friends, and we would class as doing more good than harm, skunks, weasels and badgers, if they can be kept away from the poultry yard. Toads and frogs catch insects; snakes destroy numerous insects and mice; skunks, weasels and badgers destroy insects and great numbers of undesirable rodents.



Plate XLIV. The Wyoming Ground-Squirrel.

By Permission of the Wyo. Exp. Station.

**THE
DAMAGE
DONE BY
RODENTS**

The damage done to field crops and stored grains by rodents is beyond computation. In some sections of the country one rodent will be numerous and in another some other kind will leave his mark on the farmer's profits. Like many other things which are met with on new

farms or in new countries, the rodent problem sometimes calls for intelligent and prompt action. There are places and times where prairie-dogs, prairie-squirrels, kangaroo rats and rabbits will take care of newly-planted grain crops so well that there is nothing left to sack up for the ravages of mice. Chipmunks and rats seem to enjoy digging up newly planted seeds, as well as the old-fashioned crow enjoyed pulling corn.

**NOT DIFFI-
CULT TO
KEEP THE
RASCALS
DOWN**

Neither worry nor discouragement need be caused by rodents. New land can be cleared of them sometimes by ordinary farm operations, and at others by the expenditure of a few cents, or at most a few dollars per acre. Irrigation is unpleasant to dry-climate animals that burrow in the soil, and often the irrigating of the land drives out or destroys all the undesirable inhabitants.

**GIVE THE
BOY A GUN**

It is good for every small boy nine years of age or older, to learn two things in addition to his ordinary education. He should learn to shoot and he should learn not to shoot. It is a part of a liberal education to learn to use a gun, especially a rifle. It teaches accuracy, deliberateness, nerve and muscle control, caution, activity, self-reliance, restraint, and other traits. It gives the boy the liveliest interest in out-door life and instills red and healthy blood into his veins.

The boy should learn not to shoot himself, his friends, nor the friends of his father's business. If taught not to kill birds or other things that are useful, the boy gets a first valuable lesson in economics. With a gun and a little time, a boy or two will exterminate many prairie-dogs or other rodents, and his bag of rabbits, both protects the crops and helps supply the table. The boy learns the value of game, and if properly taught, he learns to respect the laws for game protection, and not to let his desire for sport carry him beyond getting what can be readily used. Train the boy never to point, even a toy pistol, at anything he does not intend to shoot; never to leave a gun loaded or carry it cocked; that a gun is always loaded until proved empty; that the empty gun is the one that is really dangerous, and that the muzzle of a gun is its dangerous end, and there will be little probability of his meeting with any serious trouble. A gun should be an interesting instrument to any boy from ten years of age to eighty—get him one. It will make him happy—it will help on the ranch.

TRAPS

The right kind of traps are effectual means of keeping down some of the rodents. The boys of the farm often do much good catching depredating animals, and by the sale of skins or getting the bounties paid by the State, some pocket money is obtained. Small cyclone traps, at-

tended to, will do much to rid the premises of mice.

KEEPING CATS

Some good cats on a place are often most profitable stock. A mother cat with young kittens to feed, usually does much effectual hunting. In order to get the most out of cats, they must be treated and fed properly. Keep them out of doors, feed them only milk or milk and cereal foods, and make them get their own supply of meat. We have known of western farms almost cleared of rats, mice and chipmunks in a single year by a half dozen good cats.

DESTROYING RODENTS WITH GAS

Any rodents which live in holes that remain open at the top of the ground, like prairie-dogs and prairie-squirrels (often called gophers), may be effectually destroyed by smothering them with poisonous gas. In Nebraska they have used the compound from which Pintsch gas is manufactured. The more common gas for rodents is bisulphide of carbon, called "hokey pokey" or "medicine" by cowboys who sometimes put it on a horse to make him active, when a "tender-foot" gets into the saddle.

This is a vile-smelling liquid made from coal and sulphur. The commercial product is called "fuma." It sells at wholesale for about ten cents per pound. It evaporates very rapidly and is dangerously explosive if set on fire. The method of using fuma is to saturate balls of cotton, or

what serves the purpose equally well, dried horse balls, with two or three ounces of the liquid and roll them down the open burrows, after which the holes are filled with soil. The gas formed is heavy and going down into the hole kills every living thing in it. It is best used at sundown when the squirrels or dogs are at home. Badly infested lands may be cleared of these rodents at a cost of three dollars or less per acre. It cannot fail, unless too little of the liquid is used. Covering the treated holes gives a check on the work. If the rodents dig them open again the gas was either not strong enough or the animal was not at home.

**POISON FOR
RODENTS**

The most effectual way of getting rid of prairie-dogs and certain other rodents is to poison them. There has been difficulty in getting these animals to eat poisoned grain. Strychnine is usually used, and being the bitterest substance known, few animals will eat it unless the taste is covered up. A few years ago a method was discovered of doing this and still leaving the poison active. The method has been kept secret in many places.

**RECEIPT
FOR
POISONED
GRAIN**

The following receipt makes up one of the most deadly poisons known. It is sure and sudden death to anything that eats it. Therefore, take all the precautions necessary to prevent accident. One mistake might cause years of regret.



Do not use anything to mix the poison in or to keep the poisoned grain in that will ever be used for any other purpose. Buy a two-gallon glazed crock to mix the poison in and after the liquid has been stirred into the wheat use a hammer on the crock and bury the pieces. Use an iron tub to mix the grain in and then keep the tub for that purpose.

This receipt, using one bushel of wheat, will make enough poison to destroy a prairie-dog town of twenty-five hundred holes.

Take 1 bushel wheat,
3 ounces strychnine,
8 ounces cyanide of potassium,
1 teaspoonful oil anise,
2 quarts molasses,
4 quarts water,
2 quarts corn meal.

Put the strychnine in a quart of water in a tin can, and the potassium cyanide in another can with a quart of water. Set on the stove and let come to a boil, stirring with a stick to dissolve the poison. The strychnine may not all dissolve. Be *careful* not to breathe the fumes from the cyanide. Then pour the two poisons together in a larger can or the jar spoken of. Add two quarts more of warm water and the molasses and let come to a boil again. Stir thoroughly and let cool. Then add the oil of anise and stir more. Put the wheat in the tub and add the poison mixture a little at a time and mix until every grain

is wet with it. Mix in the dry corn meal to take up any excess of moisture and spread out or set away to dry. This poisoned grain may be kept an indefinite length of time in tight boxes or buckets or sacks.

**HOW TO USE
POISONED
GRAIN**

Prairie-dogs and other squirrels should be poisoned in the spring when they first come out of their burrows. They are then hungry and there is little food supply. The poison is often spread by a man on horseback. He carries a bucket or sack of poisoned grain and drops a good spoonful at or near the mouth of each hole. In a few days or a week the treatment may be repeated to get the few that may remain alive.

This poison is most deadly. It will destroy the life of anything that eats it. This is its one objectionable feature. Great care must be used not to make or put it in vessels that are used for any other purpose and not to leave it where children can get it or where the unsuspecting may feed it to chickens or other stock. Label plainly with skull and cross-bones. It must not be used in fields where hogs, sheep, chickens or larger stock are running at large. In all such places, unless stock can be kept away, use the safer gas method.

**THE POCKET
GOPHER**

This little beast is destructive and bothersome. He lives entirely underground and does three kinds of damage. He eats the roots of al-

falfa, fruit trees, garden vegetables and other things. He throws up mounds of earth which don't belong there and which dull our mowing machines, cover growing crops and interfere with harvest. He punctures the soil with holes which often seriously interfere with irrigation, breaking ditches, carrying away the water and washing the soil. There are not as many of these gophers as we would think, for one of them will throw up many mounds, twenty or more, in a day. Few know how to go about getting rid of them, so they are altogether too much left alone.

**HOW TO GET
RID OF
THESE
GOPHERS**

The pocket gopher cannot be effectively killed with gas as the ground-squirrel or prairie-dog. He may be trapped by the use of small steel traps set in the burrows or runways. It is necessary to dig a hole between the mounds to find the runway which is usually less than a foot below the surface, and the trap carefully set where the gopher will put his foot in it. Undoubtedly poisoning is the best method. A little strychnine in a piece of carrot, parsnip, potato, apple or raisin placed in the fresh runways, will do the work. A better method, perhaps, is to drop carefully a spoonful of poisoned grain in the fresh burrow.

When fresh mounds are thrown up in a field, locate the new burrow by pushing a sharpened stick or iron rod into the ground between the

mounds, until you strike the burrow. Then drop in the grain or other poisoned bait.

RABBITS

The injury by rabbits outside of merely eating crops and forage, is mainly confined to gnawing the bark of young trees, especially apples. Numerous suggestions have been made about the use of some liquid or paint to protect trees from rabbits. None of these are very effectual preventatives. There are two methods to pursue outside of destroying the rabbits. One is the use of rabbit-proof fence. Woven wire fence with two-inch mesh and eighteen or twenty inches high will keep out cottontails and jack-rabbits. The fence should be placed three or four inches under ground by plowing a furrow and at the bottom lay a galvanized barbwire with as close barbs as you can obtain. Individual tree protectors of wire or thin wood are useful and the wood ones are protection against the winds and bright sunshine as well. Rabbits may be easily and successfully trapped. The Wellhouse trap, consisting of a dark box six inches square and 20 inches long, with a trap door in front, held up by a wire inside, with a loop hanging down in the back of the box for the rabbit to push against to let the door down and shut himself in, is one of the cheapest and best traps. No bait is used and the rabbit merely runs into the trap to hide. Don't forget to visit the traps and take the rabbits out before they suffer or die of hunger.

**A WORD
ABOUT
BIRDS**

Nearly all birds are farmer's friends. You should not let the fact that birds do, at times, eat a little of your grain or fruit, irritate you. Remember that you can afford to feed them. Even if against your own intentions you occasionally supply a young chicken to a too friendly hawk or owl, you should not harbor a resentment that will cause you to indiscriminately take the life of these birds. Killing birds (or killing toads or harmless snakes) is "destroying the goose that lays the golden egg." Often successful farming is successful war against insects and weeds. The best of soldiers to enlist in this warfare are birds. There are a few exceptions, but they may be counted on the fingers of one hand, if you have lost your thumb. I would not let magpies get too numerous, for they are mischievous and great destroyers of other birds' nests. I would never fail to shoot the pesky little sparrow hawk, for he does more damage than good by warring on our better bird friends. Sparrow hawks destroy many grasshoppers, but we had better feed the grasshoppers to meadow larks and turkeys. The large-sized, rough legged or Cooper's hawks may be destroyed for the same reason. The English sparrow is a pest and altogether too numerous. When blackbirds get too thick it is well to put "four and twenty in a pie." I fully believe in the proper use of game birds in season, but too many are ignorant of the restrictions and are not law-abiding citizens in this regard. The differ-



Plate XLV. Sparrow Hawks and Cooper's Hawk.
By Permission University of Wyoming.

ent States protect insectivorous birds by law, and have specified open seasons for game. This little bird talk is not sentiment. It is pure philosophic economy.

Part VI.

LIVE STOCK.

*The rule of mind shall fill the earth
With forms to which man gives new birth.
With soil, and plant, and given time,
He turns to flesh all earthly grime.
His cattle all, both large and small
Shall thrive in field or in the stall.
For great is man and great his rod;
He's the perfect image of his true God.*



Plate XLVI. Summer Shade Adds Comfort and Contentment.

Photo by Stimson.

CHAPTER XX.

THE RANGING OF LIVE STOCK.

The nomadic range robber has disappeared before the home-builder, and a more civilized system prevails.

EXTENT OF THE RANGE

It is comparatively few years since all the arid region was range. There have been encroachments through reclamation by dry farming and irrigation. The principal condition which has broken up the general free use of the range is that the land, with water, has largely passed into private ownership. Much of the land that can be easily irrigated has been filed on under the several land laws, and the water-supply has passed into private ownership and control. A large extent of the arid region will always remain range land, and the ranging of live stock in connection with the use of the cultivable area will always be an important consideration. It is estimated that after we deduct the lands which can be irrigated, and those available for dry farming, fifty per cent. of the total area still remains as forest and grazing land.

RANGE ALL IN USE

There is no opportunity left for new settlers to enter into the business of ranging live stock in the West, unless they secure control of ranch and range by purchase or lease. The free open ranges of the West are all overstocked. During the prosperous times of the past few years sheep-

men occupying the great ranges have so increased their flocks that the forage is depleted, and undoubtedly there are many ranges upon which grazing animals do not get sufficient feed to do their best. This is evidenced by the decrease in weight of feeder lambs. Some flock owners whose lambs formerly averaged from sixty-five to seventy pounds when sold in the fall, have found them weighing less than sixty pounds even in a good season, when the only apparent reason for the decrease was the lack of food and their necessity of traveling too far to obtain it.

There are a few sections where large open ranges of public land are still in use, but they are controlled by range men, who acquire title to the water-supply and either fence the water or hire riders to see that no stock but their own gain access to it. Such range men hire a water gang that looks after the building of small reservoirs or water holes and the development and care of all the water-supply on the range. If an outsider attempts to run his stock on such range, they are kept away from the water unless the owner of the stock pays tribute to the company controlling the range.

The free use of the public domain has made it necessary that stockmen exert some management to make the business certain or profitable. This has everywhere given rise to stock associations. The cattlemen divide among themselves a certain section of the country; each knows how

many cattle he may run on the range, and lines, called dead lines, are drawn, across which the sheepmen must not range their flocks.

**RATIONAL
USE OF THE
RANGE**

Ranchmen who own lands adjoining the range territory naturally have the first right to the use of their proportion of such grazing land. The kind of stock ranged by the smaller ranchman will, of necessity, be horses or cattle, unless the range area is sufficient in size to support one or more flocks of sheep with a herder. A ranchman could not afford to hire a herder for a much less number of sheep than 2,000 head. If he has sufficient farm land to raise winter feed for this number of sheep, he should have from five to ten sections of range or from 3,000 to 6,000 acres. If he has only one section of grazing land, he may pasture upon it from ten to twenty head of cattle or horses during the season when they could not be kept in the home fields.

**AMOUNT OF
RANGE
REQUIRED**

The number of acres in native pasture which is necessary to support an animal varies in different sections of the country, depending upon the arrangements at the home ranch for the raising of pasture and feed and upon the condition of the native forage plants. Northern ranges and those of high altitudes are covered principally with short grasses, and those further south or at low altitudes may have as their principal vegetation sage brush and salt sages. Where the

range is the only dependence through the year, the area required will vary from thirty acres to fifty acres for each head of cattle or about one-tenth the amount for each sheep. Sheep bite closer than cattle and also eat many weeds and browse, not so well suited to cattle. Horses also eat grass more closely than cattle and are more active, so they can range over a larger area.

**WINTER
RANGE**

There are considerable areas in the mountain region which are still classed as desert. These deserts are not barren wastes of sand and vacant ground, but support considerable forage. There may be little or no true grass, but they generally produce variable amounts of sage brush, greasewood, bud-brush, annual weeds, and most important of all, shad-scale and other salt sages in a number of varieties. These desert areas are far away from water. The water found on them is filled with salts and alkali so it is not fit for man or beast. These lands are proving of great value for winter range where snowdrifts supply moisture for sheep. Sheep will thrive for some time without any moisture and go through the winter in good condition where they can get snow. The eastern sheep-raiser thinks that sheep should not be allowed to eat snow. Western sheepmen of long experience testify that their sheep do even better on snow in the winter than where they get water to drink. The desert forage is remarkably rich in flesh and wool forming food elements.

The alkali salts in the forage take the place of common salt, saving a large item of expense to flock masters who run their sheep at long distances from railroad points. Stock of all kinds on the range must be salted unless they can get this natural supply. The best ranchmen keep either coarse salt or rock salt before their cattle all the time. Salt is best fed in boxes and near the home ranch. In boxes, because cattle sometimes lick up enough gravel and dirt to either injure or kill them; near the home ranch because it induces the cattle to stay where they belong. An example of desert range is the red desert, in Wyoming, which covers an area about as great as Massachusetts and supplies forage through the winter for more than 2,000,000 sheep.

SUMMER RANGE

In the mountain region it is customary to use the mountains for summer range and move the flocks to the lower plains for their winter pasture. The larger part of this mountain range is now controlled by the Forest Reserves. Sheep are usually moved onto mountain ranges just before lambing, or sometimes after lambing and shearing. Cattle are taken to the mountain ranges from the ranch in the early spring or after the July roundup. Permits must be obtained from the Bureau of Forestry, and the regulations designate the particular area upon which the stock must be grazed and the fee per head which is charged for this privilege.

**IMPROVE-
MENT OF
THE RANGE**

That depleted ranges may again be brought into profitable grazing condition is well established. There is no inducement, however, to improve the open range unless the ranchman is able to control it. Wise range stockmen who are in the business to stay have secured control of these ranges either by lease or in the manner indicated under our discussion of the water control. Many western farmers now own sufficient areas of land to make the grazing of their stock in pastures an important part of their business and the grasses in these pastures may be controlled and improved in a way that could not be in the open. Many of our native grasses are perennials with root stalks. In time all these grasses will die if not allowed to re-seed themselves. They may be greatly stimulated and improved by soil cultivation. A sharp drag harrow or disc run over the pasture loosens the soil and breaks the root stalks, which makes them throw out new buds and stems.

On the open range where associations of stockmen control, the range may be kept in good condition by preventing overstocking. Some large operators do not allow more cattle on the range than the proportion of one animal to each fifty acres. This is a good suggestion for a neighborhood of farmers or ranchmen who are using the range in common, to pursue. Some of our ranges will undoubtedly support as many cattle as one head for each thirty or thirty-five

acres and still be maintained in their original productiveness. As a rule, any range can be brought back to its original value by merely giving it rest. Keeping stock off for three years enables the grasses to re-seed and thicken up, and will ordinarily be sufficient to entirely reclaim a depleted range.

Harrowing or re-seeding the range may be practicable in some instances. Harrowing greatly stimulates the growth of grass, conserves the moisture and makes the plant food in the soil available to plants. We have some drouth-resistant forage plants native to the West, which may be increased to advantage. The salt sages more especially are promising for cultivation on alkalinized soils. Western rangemen have found it very profitable to destroy the prairie-dogs, which eat large amounts of grasses. It is also probably advisable to remove poisonous plants on certain areas.

**NECESSITY
OF WINTER
FEED**

Cattlemen are finding that it is no longer possible or profitable to raise cattle on western ranges if grazing is the only dependence through the year. The percentage of increase in cattle on these ranges is too small, running from forty to fifty per cent., and under the best average, sixty per cent. of calves is considered an excellent rate of increase. Where cattle are better cared for on the ranch during the winter season the increase may reach eighty per cent. or better.



Plate XLVII. A Well-Sodded Wheat Grass Pasture.

Photo by Stimson.



Plate XLVIII. A Beef Cattle Roundup.

Photo by Stimson

Sheepmen are buying better stock and giving it better care by keeping on hand a supply of hay to feed during bad storms.

CATTLE RANGING

The management of cattle will vary in different sections and every man will have his own method after years enough of experience.

The new method of use of the range is to put the cattle into fields in November when the calves are separated from the cows and are weaned. The value of food for young stock is now generally recognized. A calf which is stunted in its early growth never makes profitable beef. These young calves, therefore, should be fed. As soon as they are weaned, they should be given alfalfa hay and native grass pasture and fed some grain in addition. Start in with a quarter or a half-pound of grain per head and increase to a pound, feeding them until the grass is good and they are turned onto the range again in the spring.

Home grains may be used for this feeding, but they must be ground. Where mill feeds are available mix a little bran, a small amount of corn chop and ground barley, spelt, or Macaroni wheat together to form the ration.

Bulls are kept in separate pastures through the winter and should be fed. It never pays to use grade bulls. While it is expensive to purchase registered sires, they are the only kind now used by up-to-date ranchmen. One bull is used

to each twenty-five to forty cows. The bulls are usually turned with the cows the first week in July and let run with them until the last of November. The calves are mostly dropped in April, at a time when spring feed is getting good. In some sections of the West, where poison weed is bad, the cattle are kept in the fields and fed during April, until this poison weed gets large enough so it is beyond being dangerous. Cattle that are turned onto the range are usually rounded up in July, when the calves are branded and the bull calves castrated.

It has become common practice to turn or sell the stock quite young. The cows should not be allowed to have their first calves before three years of age. The young stock is fed and pushed and the steers are turned usually as long two-year-olds. It does not pay to keep them longer than this if there is sufficient feed to make them of good size.

The cows should be turned at eight or nine years. In the vicinity of sugar beet factories these old cows are being fed beet tops, pulp and alfalfa hay. Cows will often go on producing calves up to the time they are twelve years old, but the best management turns them young enough so when they are fed they are salable, and bring enough to pay for fattening.

The young heaves or feeders are usually sold in November or December.

It has been common practice for many years

to cross cattle back and forth. By this we mean that a stockman will buy all pure-bred Hereford bulls. These bulls will run with the cows about four years, when they are turned and a new crop of bulls purchased. But the next time he buys full blood Short Horn bulls. Such crossing procures strong, growing young stock, and has generally given most excellent satisfaction.

With a reduction of the range area, however, better care and better breeding, many stockmen are dropping this practice and breeding only one kind of stock. Range cattle must have a continual supply of open water in the winter.

RANGING HORSES

In the early days ranging horses was one of the most profitable kinds of stock business. Western horses on the range practically take care of themselves the year round. The only attention they received or expense they were to the ranchman was rounding up once a year for purposes of branding and castrating. Early estimates placed the total expense of raising horses old enough to market at one dollar per head. With the breaking up of the large range areas and the improvement in horses, it is probably no longer advisable to attempt the raising of horses on the range. It will pay, however, to range the young stock, and the growing colts may get their food for some time on pasture. As soon as they are old enough to breed, they will require ranch management.

**RANGING
SHEEP**

It is not intended to give a complete discussion of sheep ranging. The ranging of sheep is a business in itself and does not fit into the farm management of the average settler. Undoubtedly the modern method of growing sheep in the West would be more profitable than depending upon the open range for running large flocks. A man who can fence his fields to shut out coyotes and develop a home sheep business without running large flocks and hiring a herder, would undoubtedly find the business profitable. It would be necessary to have enough range adjoining the ranch to support the sheep during the spring and summer when the fields were producing crops. The man who would buy a western sheep ranch and range and go into business on a large scale should not do so without some personal experience or securing as an associate in the business a man who has learned how.

CHAPTER XXI.

WESTERN ANIMAL FEEDING.

Do not try to keep more animals than you can feed well. Signs of Spring-time starvation are unsightly and unprofitable. Poor animals do not bring forth good offspring:—they do poor work:—they are not good meat.

FEEDING ANIMALS (FOOD)

Food is the basis of life. As we put coal under a boiler to produce heat, which may be changed into other forms of energy, as motion, electricity, or light, through the agency of steam, so we put food into our bodies for the purpose of creating energy through the agency of our life force. Perhaps we will never know just how food is converted into energy in the animal body, but we do know that it is changed and gives back heat, work and energy in various forms, and that the surplus may be stored up in the body tissues for future use.

USE OF A RATION

A ration is a certain combination of foods, given in proper amounts to keep the animal and produce some desired result. We supply food to farm animals for the purpose of producing work, which is manifested in all the life processes, and is given back to us in flesh, fat, or the work of the animals themselves. It takes a large amount of energy to keep the animal alive and to perform its various functions. For example, it has been determined that 11 per cent.

of the total energy contained in hay may be used up by a horse in the mere process of chewing the hay. Something over 2 per cent. of the energy which may be obtained from oats is used up in working the muscles which move the jaws and grind the grain so it may be digested. Some of this energy may be saved to the animal by chopping the hay and grinding the grain. Many of our best feeders have come to believe that it is a matter of economy and profit to always grind the grain which is fed to fattening animals. It takes a portion of the energy obtained from food to carry on each of the life processes in the animal, as breathing, digestion, working the heart, thinking, etc. The actual amount and right proportion of food required to carry on the life processes is called a maintenance ration, and the food eaten in addition to this supplies growth, produces work or lays on fat.

**FEEDING AS
A SCIENCE
AND AN ART**

Feeding as an art, or the practice of supplying animals with food, is as old as the livestock industry, but the science of feeding is very new. By science we mean a knowledge of why and how the various foods give the results they do when fed to various animals. Not knowing why certain foods gave certain results, our forefathers could not tell why they made or lost money from feeding their animals, and consequently made the same mistakes over and over again. However, by long experience, they did learn

something about suitable foods for different purposes, and one of the principal guides they had was the appetite of the animals themselves.

If a man is working hard and the weather is very cold, he will crave that kind of food which will supply the fat which may be converted into heat and work. The Esquimo lives on whale blubber and other fat substances, even the tallow candle being a delicacy. Such foods would very quickly nauseate a person living in a warm country. Therefore, the actual needs of the body tell the man who knows nothing about science what kind of food to eat. This was easy to apply to the intelligent thinking man, but difficult when it came to feeding dumb brutes.

The first attempt to compare feeding stuffs was made nearly 100 years ago. One hundred pounds of meadow hay was taken as a standard of comparison and was said to be worth so many pounds of other foods, as cabbage, potatoes, clover or grain. The trouble was that no one could agree on how many pounds of any food was equivalent to 100 pounds of meadow hay, and everyone used different standards.

This crude beginning set people to thinking and paved the way for better systems of determining the values of farm food stuffs. Attempts to divide feeding stuffs into different classes of compounds were not made until about 50 years ago, when Grouven's feeding standard for farm animals, based on the protein, carbo-hydrates

and fats found in food, was established. His standard would not hold, however, because he did not take into account the ability of the animal to digest these different foods and use them. His work was followed, in 1864, by the Wolfe standard, which was based upon the digestible amount of the protein, carbo-hydrates and fats in the different foods.

**A COMPAR-
ATIVELY
NEW SCIENCE**

It will be seen, therefore, that the science of foods and feeding is quite new. In fact, it is so new that undoubtedly many modifications will yet be made, and we have only the general laws to follow. It requires an enormous amount of work to determine the different amounts of the different food elements in all of the grains and fodders which we use, and they vary so much from time to time, even in the same kind of grain, or fodder, that our balanced rations are only approximate at the best. However, they are worth the most careful consideration. The scientific principle being correct, it should be applied as far as possible and may mean the difference between failure and success.

**BALANCED
RATIONS FOR
STOCK**

A balanced ration is one which contains the right proportions of the different food elements. These proportions differ with different kinds and conditions of animals. If a milk cow is fed the same ration that is given to a fattening steer, she will lay on fat, instead of giving a

profitable flow of milk. Young animals need the growth-forming nitrogen compounds. Older animals need more starch and fat. Following out these principles in even a rough, general way, always results in more profitable feeding. The key to scientific feeding is the balanced ration, and the more nearly balanced it can be made the better the results. Good rations may be made up of different combinations of feeds and one combination may be much cheaper than another. If in balance, the cheaper feed will give as good results to the animal as one that may be much more expensive.

**WHAT FOODS
CONTAIN**

Animal foods are essentially organic, i. e., they are complex substances which have been built up and compounded by some form of plant life or are taken from animals which have obtained them through plants. Animals cannot live on mineral matter alone, but some of the salts, found in the ash, when organic substances are burned, are essential to them. Sometimes they need more salt than they obtain from their natural food and it pays to supply common salt to all farm animals, or wood ashes and coal dust to fattening pigs. While the composition of organic substances is very complex, the food compounds may be grouped in the following four classes:

MINERAL

While mineral salts are necessary to supply the inorganic substances found in the bones and

other tissues, and in the secretions of the animal, they are everywhere abundant, and outside of an extra supply of common salt no attention need be given them in compounding a balanced ration.

PROTEIN

Those organic compounds, which contain nitrogen, are classed as protein. The principal forms of protein are albumen, represented by the white of eggs; gluten, the gummy substances of wheat and other grains, and casein, represented by the curd of milk. These nitrogen compounds are called albuminoids. There are a large number of albuminoids known as amides. They differ from proteids in being soluble in water and are not coagulated with heat. They are abundant in the green parts of plants. Good examples are asparagin, abundant in asparagus, and the soluble part of meat which forms the principal part of beef tea. The nutritive value of the amide compounds is not well known, though they are probably much less valuable than the proteids.

CARBO- HYDRATES AND FATS

The carbo-hydrates and fat are compounds of carbon with hydrogen and oxygen. Starch and sugar and crude fibre or cellulose are carbo-hydrates. The fats are like the carbo-hydrates in being formed of the same elements, but they contain a larger proportion of carbon and their heating value is about two and one-fourth times as much as the sugars and starches, so they are

treated as a separate class in compounding a food ration. The fats are dissolved by the chemist with ether, which also dissolves some other substances, so they are put together in our tables under the name of ether extract.

**HOW THE
FOODS ARE
USED**

In general the nitrogen substances are used in processes of growth, to lay on muscle or increase in size, so larger amounts of them are used in rations for young, growing animals, or for breeding animals, or cows giving large amounts of milk which is rich in nitrogen. The carbo-hydrates produce energy, as work and heat, and the fats both help to lay on fat and produce heat. But the complete function of the classes of food can by no means be so simply stated.

Many have the idea that a fattening ration should be especially rich in fat, but that does not follow. It is known that the animal body may break down and change the compounds, even converting one into the other. Protein may yield fat and heat, or the carbo-hydrates may be, and are largely, used to store up fat in the body. The feeder needs to supply his animals with each kind of food in the proportion best adapted to the kind of animal for the kind of results sought.

**DETERMINED
BY EXPERI-
MENT**

The amount of different foods given to animals which may be digested and used is determined by experiment, and we have only these actual feeding trials, along with the analyses of

the different foods, to guide us in computing a balanced ration, and determining what is best to feed under the circumstances. These standards of feeding are highly valuable, often enabling the farmer to save large sums by supplying his animals the correct combination of foods from the cheaper feeds on the market, and to reach the best results from his feeding in the shortest time.

THE RATION PROBLEM

Western stock foods are as different from those of the East as are our other conditions. This means that recommendations made for humid Eastern States are not suitable for the solution of our own feeding problems. In the West our fodders and grains are unusually rich in the nitrogen compounds, which we call protein. It is difficult to get enough of the fat-forming elements in our food combinations. Protein does not entirely take the place of carbohydrates and fat. This substance has been the basis upon which rations were built because it is scarce and expensive in most parts of the world. It seems to be true that animals fed a ration which is rich in protein make better growth when young than those which do not receive this growth-producing material; but older animals do not lay on the fat or make the gains they should if the ration is too rich in protein. The problem in Europe and in the East is to get enough protein; the problem in the West is to get enough carbohydrates.

**TO WIDEN
WESTERN
RATIONS**

Since the establishment of the sugar-beet factories, we have a feeding material which may be used in place of corn to widen the ration. This is the waste molasses from these factories. It contains a little nitrogenous material, but is, perhaps, two-thirds sugar, and the sugar is practically all digestible. It is usually fed by mixing with ground alfalfa or pea hay, straw or other roughage, and where it can be obtained it solves the ration problem for our farmers.

Other ways of widening rations is to mix alfalfa which is rich in protein with other grasses, grain or straw. Wilcox recommends the "straw sandwich." This is feed composed of a layer of alfalfa and a layer of straw stacked together. Timothy, Brome grass, orchard grass or wheat grass are often planted with alfalfa and the mixture helps widen the ration, i. e., makes a larger proportion of carbo-hydrates to protein.

The principal way the feeder widens his rations is by the use of corn. Other grains useful for this purpose are either the sweet or non-sacharine sorghum seeds.

It has been found that our western foods are very different in their chemical composition and digestibility from like feeds raised in the East. While the eastern analyses and tables serve a useful purpose as general indications of what and how much we should feed, they are faulty, and we must needs build up a science of arid region stock-feeding just as we must discover our

own scientific principles for other branches of farming. Some of the stations are doing much of this kind of work and are already making valuable discoveries.

**VALUE OF
BALANCED
RATION FOR
DAIRY COWS**

Wheat and corn have been found of practically equal value as stock food, but greater care must be used in feeding wheat, as it is more apt to injure stock not accustomed to it. It is a safe plan to mix wheat with some other food, as ground barley or oats, or the ground grain may be mixed with chopped hay. Some feeders successfully use wheat alone, but they are careful to feed small amounts at first, gradually increasing the feed until the animals take the full ration.

Malt sprouts is a valuable food, rich in nitrogen, but not very palatable to stock, so cows usually cannot be made to eat more than two pounds per day in connection with other feed. Malt sprouts should be soaked before feeding.

As an illustration of what may be done by the farmer in saving money on feed, by giving some attention to the computation of rations from cheaper foods, we publish the following five rations, comparing each with the standard as worked out for a 1,000 pound dairy cow giving 22 pounds of milk per day. This comparison is based upon the principle that the kind of feed is not of so great importance as a combination of foods which gives a well-balanced ration. The five rations, then, are considered approxi-

mately equal in their nutritive effect on the cow. There is a great difference in cows and if they will consume more hay in addition to the grain than that given in the ration, we would supply what will be cleaned up:

MARKET PRICE OF FEEDS USED IN THE FOLLOW-
ING RATIONS.

Alfalfa Hay, per ton.....	\$ 4.00
Corn Fodder, per ton.....	4.00
Sugar Beets, at home, per ton.....	4.00
Malt Sprouts, per ton.....	10.00
Wheat Bran (Spring Wheat), per ton.....	14.00
Corn Chop, per 100 lbs. \$1.25; per ton.....	25.00

FEEDING RATIOMS.

	Cost	Dry Matter	Protein	Carbo- hydrates	Fat	Ratio
Standard for cow giving 22 lbs. milk daily.	....	29.00	2.50	13.00	0.50	1:5.7
RATION No. 1.						
15 lbs. Alfalfa.....	3	13.74	1.65	5.94	0.18	.....
10 lbs. Corn Meal.....	12.5	8.91	0.79	6.67	0.43	.....
Total.....	15.5	22.65	2.44	12.61	0.61	1:5.7
15.5 cents per day. Cost of food for 1 cow 10 months, \$46.50.						
RATION No. 2.						
15 lbs. Alfalfa.....	3	13.74	1.65	5.94	0.18	.....
5 lbs. Corn.....	6.25	4.45	0.40	3.33	0.22	.....
5 lbs. Bran.....	3.5	4.42	0.64	2.00	0.17	.....
2 lbs. Malt Sprouts.....	1	1.80	0.37	0.74	0.03	.....
Total.....	13.75	24.41	3.06	12.01	0.60	1:4.4
13.75 cents per day. Cost of food for 1 cow 10 months, \$41.25.						
RATION No. 3.						
15 lbs. Alfalfa.....	3	13.74	1.65	5.95	0.18	.....
10 lbs. Wheat Bran.....	7	8.85	1.29	4.01	0.34	.....
10 lbs. Sugar Beets.....	2	1.35	0.11	1.02	0.01	.....
Total.....	12	23.94	3.05	10.97	0.53	1:4
12 cents per day. Cost of food for 1 cow, 10 months, \$36.00.						

RATION No. 4.				
15 lbs. Corn Fodder.....	3	8.67	0.36	5.19
10 lbs. Alfalfa.....	1.5	9.16	1.10	3.96
8 lbs. Wheat Bran.....	5.5	7.08	1.03	3.21
10 lbs. Sugar Beets.....	2	1.35	0.11	1.02
Total.....	12	26.25	2.61	13.38
12 cents per day. Cost of food for 1 cow, 10 months, \$36.00.				
RATION No. 5.				
15 lbs. Alfalfa.....	3	13.74	1.65	5.94
5 lbs. Wheat Bran.....	3.5	4.42	0.40	3.33
20 lbs. Sugar Beets.....	4	2.70	0.22	2.04
2 lbs. Malt Sprouts.....	1	1.80	0.37	0.74
Total.....	11.5	22.66	2.64	12.05
11.5 cents per day. Cost of food for 1 cow, 10 months, \$34.50.				

Comparing the results given in the tables, we find that ration No. 1 makes the cost of the food for one cow for a period of 10 months feeding, \$46.50. Ration No. 2, costing $1\frac{3}{4}$ cents per day less, makes the feed per cow for 10 months cost \$41.25. If 25 cows are being fed, this would result in a net saving to the farmer of \$131.25 over Ration No. 1. Ration No. 3 costs $3\frac{1}{2}$ cents less than No. 1, making the cost for 10 months \$36.00, or a net saving over Ration No. 1 on 25 cows of \$262.50. Ration No. 4 costs the same as No. 3, and would result in the same amount of increased bank account. Ration No. 5 costs 4 cents per day less than No. 1, and the saving on 25 cows would be \$300 more than where No. 1 is fed. It is readily seen that the difference in the cost of food may result in a profit or loss to the dairyman. Not only is it perfectly feasible to vary the rations in some such manner as that indicated, but it is a duty every feeder owes to himself. He may often take a profitable advantage of the local fluctuations in price. The farmer who has raised corn should sell it and buy wheat bran, if the prices make bran the cheaper feed.

**A SUG-
GESTION FOR
SUMMER
FEEDING**

It seems that there is good opportunity for western farmers to take advantage of the high prices of grain-fed beef in the early fall. Invariably, there is a spread of two to two and one-half cents between prices of grass-fed stuff and

corn-fed in October and early November. Cattle from some mountain ranges, like those of North Park, Colorado, are of such quality that they go as grain-fed and their beef is sold as corn-fed beef. It is not easy to produce corn-fattened beef in the hot sultry weather of the Mississippi valley or the eastern states in late summer.

**CHANGE
GRASS-FED
TO GRAIN-
FED**

With our high altitudes and dry, nippy air, even in summer, where shade is provided, and by the use of some of our less heating, fattening grains, the farmer would be able to take range feeders and reclassify them in from three to four months by grain feeding.

It would be convenient to get feeder steers at the time of the July roundups when rangemen brand their calves, and may be induced to sell their best-conditioned grass-fed beaves. Cattle are usually in good grass condition at this time and they could be put on a western grain ration by the middle of July or first of August. A short feeding period would be sufficient to make them grain fed. If young steers or baby beef are fed they could use a comparatively narrow ration.

**FEEDS TO
BE USED**

The first crop of alfalfa is usually in the stack as early as the first of July. At our lower altitudes Canada field peas, which are planted early, may be ripened and harvested by the first

week in July. This will depend on the amount of moisture, but where dry, they ripen early. Spring-sown small grains would not be available unless carried over from the previous season. Our winter feed grains, however, could be harvested in time to do the work. Winter wheat might be used in small amounts, but it is difficult to feed wheat, especially in the summer. The Winter Emmer (Spelt) can be harvested in time. This is a new grain, the seed of which is being increased and developed in northern Wyoming.

**PROTECT
FROM FLIES**

Flies worry cattle in the summer and it might be impossible to make stock fat in fly time if we were unable to meet the difficulty. No matter where we learned the trick, but we have good authority, that a certain company in the far south, where ordinarily the cattle are kept skin poor, are turning fat cattle into market off the same feed, and they keep the method a secret from neighbors and would-be competitors. The cattle are protected from flies and this protection alone has brought success to the cattle-feeding industry. The process is simple and cheap. It consists of spraying or putting on with a white-wash brush a solution of Chloro-Naptholeum as often as may be necessary. Zenoleum or other coal tar products would probably serve the same purpose. Flies don't like it.

**BALANCED
GRAIN
RATION FOR
SUMMER
FEEDING**

From the best analyses we can obtain, the following grain ration has been worked out. It is given as a suggestion to men who desire to try fitting top-priced stuff for the fall market:

20 lbs. mixed alfalfa hay and beardless barley,
or as much as the cattle will eat in addition
to their grain.

3 lbs. spelt or emmer.

2 lbs. field peas (should be ground).

4 lbs. beet molasses.

This is the amount of feed per day for each
1,000-pound steer.

If beardless barley is not available to mix with the alfalfa hay, use oat hay, or timothy or straw. Alfalfa and timothy or brome-grass hay grown in mixture would be good. Our rations are too narrow for good fattening, unless we use some combination like the one suggested. Using beet molasses and mixtures of grass or straw with alfalfa hay seems the only solution of the problem where corn is left out.

**HAY
FEEDING**

At some of our higher altitudes in Wyoming and Colorado and farther north in Montana ranchmen have practiced hay fattening of cattle for years. This is possible because of the rich and peculiar composition of the native hay grown in these localities. The higher the altitude at which a forage grows the richer it seems to be in protein. Some of these

hays from irrigated meadows are made up largely of rushes, others are principally wheat grasses, and all of them contain a variety of plants which gives a mixture of forage liked by stock. Analyses and digestion experiments have shown these hays to be quite digestible and to contain enough protein so the ration is not so wide as it would be from most hay-feeding with grass hay. The ration in Wyoming seems to be about 1 part of protein to 9 parts of digestible carbo-hydrates, fat and crude fibre. The standard ratio for a fattening steer in the finishing period is 1 part protein to 6.2 of other food elements. Where hay-fattening is practiced the feeders are usually brought from the range in October or November. They are put on the meadows upon which the hay is stacked and the stacks fenced to keep the cattle away. They are fed in these fields for a period of five or six months and given all or a little more hay each day than they will clean up. These hay-fattened animals bring top prices in the markets and are sold over the block to the consumer as corn-fed beef.

So well have hay feeders done with their stock that they are inclined to let good enough alone. However, there is no doubt that better gains could be made by using some barley or barley and flax seed to narrow the ration a little and give a small amount of richer concentrate in connection with the hay. Some ranchmen

are now growing black barley or hulless barley at altitudes of over 8,000 feet to increase the efficiency of their winter feed.

PASTURE FATTENING

Pasture fattening is letting the animals feed in the field and do their own harvesting. The dry, open falls and winters, with little snow, makes such feeding possible. The feeding is often done on a large scale by simply herding the lambs in the pea fields. This is a somewhat wasteful method, as the animals run over, tramp down and shell out much of the peas, so they get the poorest feed at the finishing period when they should have the finest and best. The use of division fences or hurdles gives better results. An acre of peas will fatten from eight to twelve lambs. They are turned on the peas the latter part of October or first of November and fed from two and one-half to four months. At first they are run on the peas a few hours and then taken off. This is repeated a few days until the lambs become used to the feed so they will not eat so much as to cause bloat. After that they are allowed to remain and eat the peas at will. Pea-fed lambs are most excellent quality meat and bring good prices. While they do not average quite so high in the market as corn and alfalfa-fed lambs, they are in good demand and the cheapness with which the fattening is done often makes such feeding highly profitable. The best farmers usually allow hogs to pasture after the

lambs to use the shelled peas which are left on the ground. Pasture-feeding peas is one of the best methods of improving the fertility of the soil.

There are other forms of pasture fattening and combinations of pasturing and feeding that are useful in the West. The pasturing of root crops, mustard, kohlrabi and rape for sheep and swine, and of artichokes by swine or of alfalfa by pigs on feed, or of beet tops by cattle or sheep, which are being fattened with grain, is profitable and important. With all these pasture crops it is important not to let stock gorge themselves at first by giving them too much when hungry, as all will cause loss from bloat. Sugar beets or tops must be fed carefully to cows in milk as they have a tendency, when fed in excess, to dry up the milk flow and sometimes they cause indigestion or paralysis. Measured by results, beet tops have a high feeding value in the first period of fattening, and feeding them results in much saving of hay and grain.

**BY-PRODUCTS
OF SUGAR
FACTORIES**

There are two important feeding products to be obtained from beet-sugar factories. One is beet molasses, which is becoming a much-sought stock food to mix with ground alfalfa or other roughage, or is fed in combination with other feeds. This seems to be an important substance to help balance up western rations. Another by-product is the beet pulp. This is a succulent

feed of low nutritive value, but when fed with alfalfa or with alfalfa and grain, it has proven generally profitable where it can be laid down at one dollar or less per ton.

Many old cows, sheep, and lambs are sent to market after being fattened on beet pulp and alfalfa alone. Such animals are soft and shrink heavily in shipping, but the cost of the feed is so low that they sometimes return a larger profit than better meat that has been grain fed.



Plate XLIX. Lambs in Feeding Pens.

In some experiments by the writer, lambs fed on beet pulp and alfalfa showed a profit of \$3.40, while those fed grain in addition to the pulp and alfalfa gave a profit of \$2.17, and those fed sugar beets, grain and alfalfa gave a profit of \$2.23.

**WESTERN
GRAINS**

The feeding value of spelt is given in the chapter on grains. Many feeders have an idea they must have corn for any stock fattening, and

**COMPARA-
TIVE VALUES
OF FEEDS**

often they feed corn and alfalfa when corn costs \$1.30 or more per hundred pounds, and wheat or barley could be obtained for considerably less. Some Colorado experiments show that when lambs were finished on wheat this grain gave a value 15 per cent. greater than corn, and average results show that wheat is equal to or a little better than corn, pound for pound. Barley is worth a little less than wheat in general feeding value, but it is easier to feed and often the difference in price makes barley the most profitable grain to use. Oats, spelt, or barley are, undoubtedly, better grains to feed to breeding stock than corn. The western farmer should get away from some of his old ideas and take hold of a few new ones. Undoubtedly corn is one of the best feed grains in the world and corn fodder seems to be more valuable than almost any other roughage of that nature. Alfalfa hay is worth from two to three times as much as corn fodder. The following table of comparative food values, furnished by Dr. B. F. Kaupp, is of considerable interest:

ROUGHNESS.

Value a ton when alfalfa is worth \$1.00 a ton.

DRY ROUGHAGE.	Total
	Nutrients
Alfalfa	\$1.00
Corn fodder .....	.32
Cow peas .....	.97
Fodder corn .....	.40
Millet .....	.64
Oat hay .....	.59
Oat straw .....	.33

	Total Nutrients
Orchard grass	\$.60
Prairie hay .....	.51
Red clover .....	.70
Sorghum .....	.43
Soy beans .....	.98
Mixed hay .....	.67
Timothy .....	.47
Wheat straw .....	.25
Pea vine .....	.93

GREEN ROUGHAGE.

Alfalfa	\$.34
Corn Silage .....	.13
Fodder corn .....	.14
Pasture grasses .....	.23
Sorghum fodder .....	.12
Soy beans .....	.28

ROOTS AND TUBERS.

Mangels	\$.10
Sugar beets .....	.14
Turnips .....	.11

GRAINS AND BY-PRODUCTS.

Value a 100 lbs. when corn is worth 10c a 100 lbs.

	Total Nutrients
CONCENTRATE FEEDS.	
Barley	\$.10
Broom corn seed .....	.08
Corn .....	.10
Corn and cob meal .....	.07
Cow peas .....	.15
Cotton seed hulls .....	.02
Cotton seed meal .....	.28
Flaxseed .....	.18
Chicago gluten meal .....	.21
Kaffir corn seed .....	.09
Linseed meal .....	.22
Millet seed .....	.09
Oats .....	.09
Rye .....	.11
Sorghum seed .....	.08
Soy bean meal .....	.25
Wheat .....	.11
Wheat bran .....	.10
Wheat middlings .....	.12
Wheat shorts .....	.11

MILK.	Total Nutrients
Whole milk	\$.03
Skim milk .....	.02
Whay .....	.008
Buttermilk .....	.03

This table is not of much importance for the West, further than to serve as a rough indication of comparative values. As it is the table means, that if your alfalfa hay is worth ten dollars per ton the food in your timothy would be worth \$4.70. If your corn costs \$1.00 per hundred, your barley would be worth \$1.00; your wheat, from its food contents, \$1.10, and your sorghum seed 80 cents per hundred pounds. Such comparison may serve as a general guide in buying or selecting feeds which are cheapest and will give most profit from their use.

ALFALFA FOR HORSES

Many still entertain the opinion that alfalfa does not make good horse hay. They think it effects the kidneys badly. The trouble is more apparent than real. Alfalfa hay contains considerable moisture and the water is passed off by the kidneys or stores up in the tissue, making an animal sweat, if it has been fed for some time without being worked or exercised. At the same time, the color of the hay causes stains in the stall, making it appear that the secretion is unusually great. Alfalfa hay does sometimes cause trouble when fed to horses which are not used to it, but the trouble is usually indigestion,

due to the way it is fed, rather than to any bad qualities in the hay. Alfalfa has over twice as much nutriment in it as the best timothy, and is so rich and palatable that horses may founder themselves or have their digestion disarranged, and be affected with kidney or other troubles if fed all they will eat of it when not accustomed to such feed. The same thing occurs when a hungry horse gets loose in a corn-crib or an oat-bin. Indigestion is often mistaken for kidney trouble.

When properly used, alfalfa is good hay even for work horses, and it is doubtful if there is any other hay equal to it for colts. Thousands of work horses on farms in the West get no other kind of hay, and they live as long and do as much hard work as farm horses anywhere. The first cutting makes the best horse hay, and they do better on it if it is allowed to get pretty ripe.

CHAPTER XXII.

STOCK BREEDING SUGGESTIONS.

Reproduction is the basis of the creation of new wealth.

POINTERS ON BREEDING

We make no attempt to discuss the principles of animal breeding. There are a few points useful to the farmer who is raising any kind of live stock. He should grow the kind of stock suitable to his farm. If he has range he should make use of it. In the arid region the foods are rich in the growth-forming materials and are especially suitable to the feeding of young stock. The bacon hog, in which the object is to make meat instead of lard, is especially suited to the alfalfa districts. The farmer should always use pure-bred sires. Grades do not pay. It often pays to make a first cross for feeders, but the crossed animals should not be used as sires, even though they appear to be good stock, for the offspring of grade sires is uncertain and deteriorates. For various causes some animals will be non-breeders or sterile. Unless the animal is a valuable one, so it will pay to consult a veterinarian, as soon as proven to be a non-breeder it should be fattened and sold. Contagious abortion sometimes interferes with the breeding. Where this occurs the disease should be cleaned



Plate L. "Full Bloods" on the Home Meadows at Careyhurst. Photo by Stimson.

up by the advice of a doctor, or the diseased animals disposed of.

**PUBERTY,
HEAT AND
GESTATION**

The age of puberty, or the time a young animal will breed, varies greatly in different animals of the same kind. The periods of breeding are also variable, but the gestation is more uniform. It seems that highly bred animals that mature at younger ages, have shorter gestation periods than the less refined breeds. This information is scattered and usually hard to find, but it is so useful to every farmer who deals with any kind of live stock that such of it as is available and reliable is here brought together in condensed form.

THE HORSE

Puberty in the mare occurs at from eighteen months to two years of age, but the mare should not be allowed to have her first colt younger than three years. Animals indicate when they are ready to breed by periods of heat or rutting (oestrus). The mare comes into heat every twenty-one or twenty-two days, though it varies from one to three weeks, and some mares are apparently in heat at all times, while others never come into heat at all. Heat does not usually occur while animals are pregnant, though this is not always true. The mare usually stays in heat about three days. The gestation period of the mare (the time she carries the foal) varies from ten months to twelve months, the average

time being 336 days. A mare will raise colts until more than twenty-five years of age.

THE COW

Puberty in the cow occurs at from nine months old to two years old. Dairy breeds may be bred very young, but beef cattle should not be allowed to have calves before two and one-half years old. Cows usually come in heat every twenty-one days, and the periods of heat last from one to four days, the average being about thirty-six hours. The gestation period of the cow is nine months, the average length of time being 183 days. Heifer calves usually drop in 182 days, and bull calves take one or two days longer. Young heifers with first calf, and small cows often go a day or two less.

SHEEP AND GOATS

The lamb sometimes reaches puberty as early as five months of age. With most breeds of sheep the heat or rutting season only comes in the fall months. It usually begins about the middle of September, lasts about twenty-four hours, and recurs every fourteen to sixteen days until the end of December. Some breeds, like the Dorsett, may be made to breed at other seasons of the year. This is much influenced by the character of feed and treatment. The period of gestation in the sheep and the goat is five months, the average time being 148 or 149 days. The Rambouillet carries its lambs one or two days less time than the American Merino, and

the coarse-wooled breeds have gestation periods three or four days shorter than fine-wool sheep.

SWINE

The sow reaches puberty at about six months, but brood sows should not be bred as young as this. Sows come into heat in periods of from one to three weeks and stay about one day. They do not come into heat while nursing their pigs, and if it is desired to get a quick second litter, the sow should be bred the day after farrowing, or the pigs should be weaned early. Some breeds may produce two litters of pigs a year, and while breeding so often is not unusual, some good breeders prefer only one litter each year. The gestation period of the sow is four months, averaging 119 or 120 days.

**OTHER
ANIMALS**

The bitch comes into heat once in six months, usually in the Spring and autumn, and the rutting period lasts from eight to fifteen days. The gestation period in dogs is from two months to nine weeks, the average varying from fifty-six to sixty-five days.

The gestation period in the cat is about two months or fifty-five days. In the rabbit it is twenty-eight days, and in the guinea pig thirty-two days.

**CARE OF
MOTHERS**

One of the secrets of good and profitable offspring is an abundant natural food supply. The best mothers supply the largest quantity of milk.

Sometimes milking quality is an inherited character in the breed, but it may often be aided and improved by proper feed and care. Animals carrying young should be fed nitrogenous and succulent feed. Where mill feeds can be obtained bran and shorts are usually recommended. Good grains to feed bearing ewes or cows are barley or spelt. Oats are a most excellent feed for breeding horses, cows, sheep, or swine. Some swine breeders use oats very freely to feed their brood sows. Succulent roots are good. Care must be taken not to feed too heavily of sugar beets to cows in calf, as it may cause paralysis and abortion, and over-feeding with beets tends to dry up the milk flow. Animals carrying young should be kept in good condition, but should not be fed heating or fattening rations.

Animals about to give birth to young, unless on the range, should be given good, roomy, dry and comfortable quarters in box stalls or yards.

Sows should have a house so constructed that the mothers are prevented from lying down on the pigs. An "A" pig house is good. The nest may be provided with a two by six-inch plank projecting around the edges and placed six or seven inches from the floor. The little pigs may be pushed or squeezed under this guard without killing or injuring them. Sows sometimes devour their young. This is usually due to improper feeding with heating or fattening foods

or with a ration much out of balance. It may be caused by indigestion or bad physical condition. If it becomes a habit the sow should be fattened and butchered or sold.

WEANING

With dairy cows the best practice seems to be never to let the calf nurse its mother. The first, or colostrum milk, should all be fed to the calf, as no artificial food can take the place of this natural secretion. The calves should be far enough removed from their mothers to be "out of sight and out of mind." It is probably better to teach them to drink at once than it is to bother with any of the patent nipples, teats, or feeding devices on the market. Stock calves are usually weaned when they are six or seven months of age. Colts are weaned at five or six months old. Lambs are weaned at four months, and pigs at two months. Usually all that is necessary is to separate them from their mothers, and give plenty of other food.

CHAPTER XXIII.

COMMON DISEASES OF LIVE STOCK.

Dumb animals are man's most dependable friends, and they must depend on him for the blessings they enjoy, and their ability to give something in return.

VETERINARY MANAGE- MENT

By veterinary management we mean the common farm surgery which must be practiced on animals and the treatment and nursing of those that may be ailing. Much of the success in the treatment of any disease by the farmer and stockman will depend upon the point of view. The farmer should remember that medicines do not cure disease; that nature always makes a tremendous effort to bring about recovery. The use of remedial measures is for the purpose of aiding nature. If you look upon the treatment of your animals from this standpoint, you will be more cautious, more humane, and more successful.

DRY CLIMATE HEALTHFUL

There is probably no place in the world where live stock of all kinds is generally more healthy than in the arid regions of the West. The loss we suffer is not so much from the ravages of any one or more contagious diseases as it is from the aggregate loss incident to innumerable minor things, such as accidents, colics, poisonous plants, etc. Most of this loss is attribu-

table either to ignorance or carelessness, and is preventable.

**RECOGNITION
OF DISEASE**

The ability to recognize the more common diseases of live stock by the farmer and stockman is often the means of saving the lives of valuable animals. A knowledge of how to prevent disease is of vastly more importance.

**AVOID
TROUBLE BY
GIVING
GOOD CARE**

Domestic animals have lost the power of rustling for themselves. They have become dependent upon the personal attention of man. It is said that wild cattle will not eat poisonous plants, but tame ones do not seem to discriminate. They take what man gives them.

While it is often true that germs cause disease, and are the real and only cause of the disease, yet the fact remains that animals well cared for are not so predisposed to disease. This rule holds good at every stage of the game in the live stock business.

Feed your live stock from the day they are born;—feed them well. It will not pay to keep them unless you are prepared to feed them.

In the arid region we have the very best possible sanitary conditions. If animals are not penned up too closely or given dirty quarters, they naturally keep well. A good, pure water-supply should always be available. Be cautious about feeding any food that is mouldy, musty,

dirty, or of a poisonous nature. Most farmers imagine that water that is not fit for human use is still good enough for their stock.

**STABLES
AND
SHELTER**

With our dry air and little precipitation, animals do not need the close housing which is given in the East. Dry air does not carry with it penetrating cold. As a rule, animals do better in the arid regions if kept outdoors. It is important to protect them against winds, which can be done with shelter belts or wind-breaks. It is not necessary to build warm, close stables for horses or cows. General shelter sheds or fences, however, are important where stock is being fed.

**DO NOT
EXPERIMENT**

The farmer should attempt to do nothing for sick animals if he does not know what the trouble is or what the effect of his attempt will probably be. In cases of complicated disease, and especially where it proves to be contagious or infectious, going from one animal to another, he should call a qualified veterinarian. It is easy, however, for him to become acquainted with the more common and simple troubles and successfully treat them on the ranch. The central idea is to see that healthy animals receive the best care and attention, and when animals are sick the first thing is always to get them comfortable and make their surroundings such that nature may do her best. Then, if you can

assist by the use of certain remedies, very well; but do not experiment. Always separate your sick animals from those that are well.

THE HORSE'S FOOT

Here is where you are likely to get the worst of it in a horse trade. There is an old saying, "No foot, no horse." There are more diseases in the front feet of a horse to render him unfit for service than all the other diseases combined.

The horse should have a broad, deep foot, with wide heels, and his pastern should stand out at an angle of forty-five degrees. There is more weight on the front feet than there is on the hind feet, and from the shape of the leg it is readily seen that there is more concussion on the front feet.

Shoeing always injures the feet, no matter how well it is done. If it is necessary to keep the feet shod, do not allow your horse-shoer to touch the feet with buttress or rasp any more than is necessary to remove any loose scales or horn. Do not leave the shoes on more than six weeks without resetting. Remember that the foot grows larger as it grows down, and the nails must give a little or the foot will be pinched. The side along the toe changes the angle of the bones in the feet and one or all of these things combined are sufficient in most cases to bring on one or more of several diseases of the feet. Perhaps you are shoeing your horses more than

is necessary. Remember that the bare feet will stand lots of wear until they have once been shod. Do not get into the horse-shoeing habit and think that a farm horse must be shod just because he is a horse. In buying a horse, look well to the feet.

COLICS IN THE HORSE

Is your horse subject to regular attacks of the colic? If so, the first thing is to see that his teeth are in good condition; then look to the quality of his food. The worst colics are produced by feeding corn or too much concentrated food, such as wheat or barley or alfalfa. It simply means indigestion. But what are you going to do when he is sick? If you are living in a remote district and a veterinarian can not be secured, the following suggestions may be of some service:

In the first place, let's look to the "don'ts."

SOME DON'TS

Do not begin by giving everything that some wise neighbor may suggest—he having gotten the remedy from his grandfather, who, according to tradition, gave some old "geeser" five dollars for the remedy because it was known to be a "dead shot" cure. Remember that most horses that have colic will recover without treatment. If you do not know what to do, do nothing but give the horse a good bed to roll on, making him as comfortable as possible. Do not pour medi-

cine down the horse's nose; nature never intended that way. Neither try to blow powder down his throat—the horse may blow first. Do not terrorize the animal by chasing him around and forcing him to exercise. There are more foolish things done for a colicky horse—done with the best intentions; in fact, so much is usually done that the horse simply gives up in despair and dies, when he might have recovered had he been left to himself. The greatest mistake made in this connection is the common belief that because a horse stretches himself out when he has colic there is necessarily something wrong with his kidneys or bladder. Very seldom is there anything wrong with the horse's bladder or his kidneys; but when he has pain in his bowels he likes to stretch the muscles over his belly by getting his front and hind legs far apart. Further than that, it is a fact that a horse has cramps in his bowels if he is unable to relieve the bladder. However, the bladder will not suffer from distention for several hours. The result of this common mistake is to give the horse sweet spirits of nitre for his kidneys, or perhaps a little buchu or rosin.

**TREATMENT
OF COLIC**

Assuming that you are far from town, with no competent veterinarian available, and have only household remedies upon which to depend, we will suggest that you give an ounce of tur-

pentine in a pint of raw linseed oil to stop the fermentation in the bowels and the accumulation of gas. To relieve the pain you will no doubt have at hand some tincture of opium (laudanum), which you can give, say, an ounce in a pint of water. No matter what the remedy is, the central idea in treatment for colic is to remove the irritating food in the bowels by means of physics and injections in the rectum of warm water; to stop fermentation of the food by giving anti-ferments, such as salicylic acid, creoline, turpentine, etc., and to remove the pain by means of such remedies as opium, morphine, chloral hydrate, cannabis indica, etc.

BLACKLEG

Blackleg (*Symptomatic anthrax*) is quite prevalent among live stock in the arid region. Fortunately the disease affects only young cattle and the young of other species. There is no use trying to treat the animals if they once get the disease. The only hope lies in prevention. All preventive measures tried have failed to be of much service except vaccination. Many stockmen have lost faith in the efficacy of vaccination, mainly because it has been their custom to wait until the disease has broken out among the calves. In cases like this a number of calves will be sure to die, even though they have been vaccinated. The way to do is to vaccinate twice each year and make it a regular chore. Get some good

vaccine, either in powder or pill form, give it according to directions, and be very careful in every detail so that you are sure you have vaccinated every calf. Vaccine may be secured from the U. S. Department of Agriculture, from the Colorado Agricultural College, the Kansas Agricultural College, and several private firms. Blackleg is a germ disease; therefore the carcasses should be burned or deeply buried in the ground.

GLANDERS

Glanders affects mostly the equine (horse, ass and mule) family; there is no cure for the disease. It is a very dangerous disease, as it is often transmitted to the human. A horse that has a chronic discharge from the nose and does not seem to be thriving, needs attention at once, and the fact should immediately be reported to the State authorities. The mallein test is given to be sure of the disease. The animals are condemned and destroyed. In some States the Legislatures reimburse the owner in part, at least, for loss from glanders.

TUBERCULOSIS OF CATTLE

Since Koch discovered the germ which produces the disease, the investigation of scientists have kept up a lively general interest in the cause, spread, prevention, and cure of phthisis, or consumption. This is recognized as the most common and the worst disease in the world. Not

only is it a destroyer of more human lives than any other disease afflicting man, but it also infests birds and almost all kinds of animals, from the frog to the rhinoceros. Among domesticated animals, the horse and the sheep are comparatively free from tubercle, while the cow seems to be the natural host of bacillus tuberculosis. The supposed identity of human and bovine tuberculosis has made the matter of more serious import than would be the case if direct financial loss to the cattle industry or swine raising was the only consideration. The health and safety of ourselves and our families are concerned and we should neither harbor diseased animals nor use their products. The open dry air and sunshine of the arid region is a natural preventive of tuberculosis, and our stock are not apt to contract the disease at home unless we bring infected animals from the East. The Tuberculin test is a sure diagnosis of this trouble and no farmer should *ever buy or use a milk cow or an expensive breeding animal without first having it tested* with tuberculin.

INFECTIOUS ANEMIA

This is comparatively a new disease of horses in the West. It has been called "swamp fever," "horse typhoid," "no-name disease," etc. The symptoms of this disease are not easily described although they are known. The mucus membrane of the mouth looks pallid; there may be

some swelling of the hind legs (stocking); but in the main the only symptoms are that the animal sweats easily, appears to be feverish at times, stands around yawning like a tired person, eats well, but gradually grows weaker. Most all these cases die at from six weeks to a year and a half. The U. S. Department of Agriculture has investigated the disease. Up to this time there is no treatment that is to be recommended.

**FOOT AND
MOUTH,
DISEASE**

This disease is one of the four great bovine scourges. It has made its appearance twice in the Eastern States, and the U. S. Department of Agriculture is now spending large sums of money trying to exterminate it from the country. If it ever gets into the Western States, where live stock range unrestricted in many counties, it will be practically impossible to exterminate the disease, and the damage to the live stock industry of the West can scarcely be conceived. If you see any cattle suffering with the following symptoms, report it to the State or Federal authorities at once.

**SYMPTOMS
OF FOOT
AND MOUTH
DISEASE**

A sore mouth, the animal slobbering and refusing to eat. An examination of the mouth will reveal the presence of ulcers and the membrane will be fiery red from inflammation. The feet will be sore and the animal scarcely able to walk. There is a high fever. If in a cow, the

milk secretion will stop. The horns are hot and the disease spreads rapidly to the other animals of the same species.

DISTEMPER

Distemper (colt strangles) is a disease of young horses and is found in all parts of the West. It is probably more prevalent in the spring time. It is an infectious disease.

SYMPTOMS

The colt appears to be feverish, stupid, does not eat well; appears to be tired and draws great quantities of water. In two or three days the throat is found to be very sore and there is usually a swelling behind the angles of the jaws. In two or three days more this swelling softens and pus is discharged freely. If the disease runs a normal course, the colt recovers within a week or two. If it runs an irregular course, it may mean the accumulation of pus in the guttural pouches just below the ears on one or both sides. There may be inflammation of the throat that strangles the colt and makes breathing difficult. There is likely to be inflammation of the lungs. Or, a bad diarrhœa may set in. One of the worst complications shows itself two or three weeks after the colt has apparently recovered. A swelling will suddenly appear in some unusual place on the body. Within a day or two this will be found filled with pus; soon other abscesses will appear and the animal is in very bad shape.

**TREATMENT
OF DIS-
TEMPER**

The all-important thing when the animal first comes down is to see that the colt does not get wet; that he is kept in and given a little grain and the very best of care. Other complications should be treated as they appear. The throat can be poulticed and the guttural pouches opened from the outside. Abscesses on the body should always be opened with a sharp knife as soon as they become soft. If the colt is choking badly from the inflammation in the throat, he may be treated by causing him to inhale carbolized steam. Put two quarts of bran into a gunny sack and dip it into a pailful of boiling-hot water, in which has been placed a tablespoonful of carbolic acid. Lift the sack over the head, allowing him to inhale the vapor.

**HOVEN OR
BLOAT**

Bloat is caused by the rapid formation of gas in the paunch of cattle or sheep. It is caused from over-eating of green or succulent food, which ferments before it can digest. Bloat is a very common trouble in the West where alfalfa is pastured or where other green forage is used, such as peas, rape, or clover. Sometimes dry alfalfa hay causes bloating when it is very fine stemmed, leafy and moist. If the bloating is severe it causes the death of the animal through stopping the heart and pressure on the lungs. Animals which show that they are filling up with gas should be attended to promptly. Cattle may be relieved by puncturing the rumen or

paunch with a knife or trocar and canula. Always do this on the *left* side, half way between the hip bone and the ribs. In severe cases I have known a farmer to use a butcher-knife and make a hole large enough to run in his hand and pull out the alfalfa. This is not necessary, as a hole large enough to allow the gas to escape is sufficient. A trocar and canula should be kept for the purpose. Many recommend the same treatment for bloat in lambs or sheep, but while the treatment is always successful, the sheep so treated usually dies. A better remedy with lambs is to use the "probang." This is simply a piece of rubber hose one-half inch in diameter and three or four feet long. Block the mouth of the sheep open so it cannot bite off the tube and then run it down into the paunch like a stomach pump. Work it around until the gas is reached and allowed to escape. In several years' experience feeding lambs at a high altitude where the alfalfa hay produced bloat in many animals, we never lost a lamb where they were discovered in time, and we could get to them with our rubber tube before they died.

**GRAIN
GORGING**

Often a horse or cow will get loose and help themselves to grain from a bin or sack left where they can reach it. Such gorging often produces the death of the animal unless it is discovered in time. Physic such an animal at once. Give the horse a quart of raw linseed oil and the cow

a pound or two of glauber salts as a drench. The veterinary doctor also injects eserine to produce action of the bowels, and where they get to a case in time they are pretty sure to save the animal.

MILK FEVER

Dairy cows often have milk fever soon after calving. They usually get down and so sick they are unconscious before the disease is discovered. A remedy has been found which is so simple and sure that it is no less than marvelous. This remedy is to milk out the udder and then force air into the teats until the udder is blown up like a balloon. This may be done with a bicycle pump and any small tube that can be pushed into the teat opening. A cow that is apparently dead when given this treatment will usually revive and be on her feet in an hour after it is done. The after-treatment consists of careful feeding with bran mash and often some stimulant like four ounces of whiskey or two ounces of Jamaica ginger is given every four hours, for a day or two.

CONTAGIOUS ABORTION

Contagious abortion causes much loss with cattle. It is transmitted from one cow to another or by infected bulls, and the surest remedy is to get rid of infected animals by sending them to slaughter. Mayo says that salting pregnant cows two or three times a week with a small handful of a mixture of ten pounds of common

salt, one pound of sulphur, and one pound of pulverized hyposulphate of soda seems a good preventive. If animals that are valuable become affected they may be cured by thorough and often repeated disinfection. The stable should be thoroughly disinfected with 5 per cent. carbolic acid solution. Anyone who would try to cure the trouble should do so under the advice of some one who has had experience.

On nearly all cattle ranges contagious abortion is present and causes more or less loss. The best range practice in dealing with this disease seems to be to promptly and carefully bury or burn the dead calf and tissues and isolate the cow in a pasture or field kept for that purpose. Send such cows to market as soon as in condition or a shipment of other stock is made. One large range man in the West says he has kept his loss from abortion down to less than one per cent. by this method.

CHAPTER XXIV.

POISONOUS PLANTS OF THE WEST.

Poisonous plants occur locally, and when they are found our domesticated animals have no more sense than to eat them.

POISONOUS PLANTS

Poison weeds are sometimes a serious problem with the western stockman, and almost all the trouble is caused by about six different species of plants. Every stockman should at least be able to identify these plants in order that he may become familiar with them and take some measure to avoid them.

LOCO WEED

There are several species of loco weed, but two, the white and purple loco, are known to be the chief offenders. The U. S. Department of Agriculture, in conjunction with the Colorado Experiment Station, has been investigating the loco problem the last four years. They report that the poison in the weed is the inorganic substance, barium. Up to the present time an effective remedy or an antidote has not been determined. Loco leaves its impress upon the nervous system to such an extent that altho the animal seems to have fully recovered from its effects it may break out at any time. A locoed horse may not show that he is diseased, unless he is

heated up or excited. The first thing to do is to become familiar with the plants and with the symptoms of the disease, keeping the live stock away from it. When a locoed animal is found it should be immediately taken up, given a good physic, and then plenty of grain. Sheep and cattle, if not too badly locoed, will make a fairly good recovery, put on flesh, and may be sold for the block. It seems useless to try to exterminate loco weeds from the range. The symptoms of the disease are lack of thrift, temporary blindness and crazy staggers.

LARKSPUR

In amount of damage done to livestock interests of the West larkspur is second in importance only to loco. It is widely spread and in many places the only serious poison weed. There are several different species of larkspur. These are commonly known as the tall and the dwarf larkspur. It appears that they are all poisonous and they may all be recognized when in bloom from the characteristic color (blue) and shape of the flower. Larkspur does its damage to live stock in the early spring, and almost invariably just after a rain or a snow storm.

**SYMPTOMS OF
LARKSPUR
POISONING**

The animal is seen to stiffen its legs and will stroll along for a while and finally fall; and it will be found to be bloated much the same as from eating alfalfa. The animal slobbers at the mouth and swallows continually.

**TREATMENT
OF
LARKSPUR**

If the animal is extremely bloated, it should be tapped through the left side, high up, with a trocar, or, in the absence of a trocar, with a jack-knife. It should be pulled around, if necessary, and its head turned uphill. The stockmen claim there is much benefit derived from bleeding the animal from the ear vein or under the tail. Potassium permanganate, twenty grains to a pint of water, poured down the animal's throat, is a chemical antidote and is almost a sure cure. The active poison in the plant is *Delphinine*, and it kills by depressing the heart's action and the breathing.

DEATH CAMA

This plant has a bulb and looks somewhat like the wild onion. It grows sparingly in the ravines and sometimes over the western ranges on either side of the Rocky Mountains. It is a very deadly plant, but fortunately grows so sparsely that animals seldom get enough at any one time to kill them. In the case of poison it is usually not more than one or two of a herd that become affected, not like larkspur, where fifty or a hundred may get down at one time. There is no known cure for Camus poisoning.

**WILD
PARSNIP**

The wild parsnip (Wyoming water hemlock) is a deadly plant, but fortunately the poison is mostly in the roots. The roots pull easily with the plant, and are sometimes eaten with deadly effect. The plant grows along ditch

banks and in wet meadows. It has an umbrella-shaped top and looks something like the garden parsnip.

**SYMPTOMS
OF
PARSNIP
POISONING**

In the case of poisoning by this plant the animal is thrown in convulsions and the most excruciating pain. He will thrash his head upon the ground; the abdominal muscles will draw up convulsively and there will be passage of blood from the bowels and often with the urine. Only one or two animals in a herd are poisoned at a time. Treatment is not often effectual. The remedy is prevention, by digging out the plants.

LUPINE

This plant grows all over the West, by the roadside, in the meadows, and on the sides of the mountains. It grows one to three feet high and has a bright blue flower. When it goes to seed it has a pod which resembles the garden bean; hence the name "Buffalo bean." The only part of the plant that is poisonous is the seed. The plant is often cut for hay and makes most excellent forage. The only thing to guard against is that it be not cut after it has gone to seed. Or, if it is cut for hay late in the season, it should be harvested only after the pods have broken open and the seeds have fallen to the ground.

**SYMPTOMS
OF
LUPINOSIS**

The symptoms in sheep that have eaten the seeds of lupine are unmistakable. The sheep

appear to be blind; they will fall over one another, run into the fences, and they may go into convulsions. If they get lupinosis in a chronic form, the skin turns yellow. Horses are affected in the same way, more commonly with the chronic form.

**OTHER
POISONOUS
PLANTS**

There are many poisonous plants that are occasionally eaten with more or less disastrous effects. The branches and leaves of the wild cherry, just at the time of wilting, will kill an animal quickly from prussic acid poisoning. The same may be said of Johnson grass. Second growth sorghum and Kafir corn, when grown in a stunted condition, will often kill from the same cause. Musty oats will seriously affect the horse's kidneys. Mold that grows on potatoes, carrots, and other vegetables in damp cellars, or mouldy sugar beet tops in the field are dangerous when eaten by animals. Potatoes exposed to the sun turn green and become poisonous. The Rubber weed does not kill by the presence of a poison, but by fatally obstructing the bowels. The Giant grass, or horsetail, that grows in sloughs and is relished by horses, is often deadly.

The so-called skunk cabbage (Wild lobelia), grows from three to six feet high in the lofty ravines and has a leaf as big as the hand. It is very poisonous to live stock.

The Monk's hood (aconite) has a purple flower and is shaped, as its name implies, like a

monk's hood. This plant is very deadly, but is not often eaten by live stock. All stockmen should become familiar with the plants to which their stock has access, especially those that may be poisonous.

CHAPTER XXV.

COMMON FARM SURGERY.

The Secret of Success in Surgery is Cleanliness.

COMMON SURGERY ON THE FARM

There is a certain amount of surgery necessary on the farm that can be done by the farmer himself or one of his men who chances to be handy at such things.

DEHORNING

If the ranchman raises a breed of cattle that grows horns, he must amputate the horns. Horns may be useful on the open range, where bulls must fight and the survival of the fittest makes it important that the strongest gains ascendancy, but they are useless and worse than useless in the home field or in the feed lot.

There are three ways of getting rid of the horns. One is to make a circle around the button, when the calf is a week old, with a sharp knife and remove the horn core entirely. This method is to be recommended on the farm, but is not useful under range conditions, because the calves are not at hand when the operation should be performed.

Another method of dehorning is to use the dehorning shears, of which there are several different kinds on the market. The important thing is to have them sharp and to have your

stocks fixed so that they can be properly secured for the operation. In using the shears it is necessary to cut the horn off very close to the head.

A third method is to use a sharp saw. This is to be recommended for old animals after the horn has become hollow and brittle.

Dehorning by the use of chemicals, such as caustic potash, etc., is so unsatisfactory in many cases that it is not to be recommended.

BREEDING OFF THE HORNS

The most modern cattle are those which are polled or naturally hornless. Rangemen have long thought that cattle with horns were more hardy or presented some other advantage where they must survive on the open range. The day of the open range is past, except as it is used in connection with the home ranch. There has been such a great improvement in breeds of cattle the past few years that there are hornless strains of the most important ones. Polled Angus and Galloways, and the Red Polled cattle and Polled Short Horns have been carefully bred and improved, and we now have a polled Hereford, which promises to take the place of the old horned tribes.

DETAILING

The tail of a sheep seems to serve no useful purpose. There are so many reasons why it should be removed and so few reasons why it should not, that it has become the general prac-

tice to cut off the tails of lambs when they are a few weeks old.

**THE WAY TO
DO IT**

The lamb is caught and thrown upon its back. The attendant sits across its neck, grasping the hind legs of the lamb and holding them far forward, while the operator grasps the tail about three inches from the body with his left hand, pushes the skin up on the tail, and with one downward sweep of the knife cuts off the tail at the joint. Now, if the operator is not on his guard, the blood from the severed artery will spurt into his face. One of the difficulties of the operation has been the excessive bleeding which follows. Various methods have been adopted to check this loss of blood, such as burning the stub of the tail with a hot iron, the use of caustic, tying the end of the tail with a string or cloth, etc.

Here is a suggestion which, if adopted, will make this matter of hemorrhage a thing of least importance. Go into the drug store, or to a physician, or send away to some instrument house and get some artery forceps, which will cost a dollar or two. Having these little forceps at hand when the tail has been cut off, you simply grasp the bleeding artery that protrudes and can always be caught at the first attempt. Close your forceps on the artery, twist the instrument once and a half around, remove the forceps, and the bleeding has stopped.

In cutting off the tails of sheep the same as with other farm operations, the greatest of care should be exercised in having the instrument in hand perfectly clean. A good antiseptic to use on the instruments and the hands and as a dressing for all kinds of wounds on the farm, for man and beast, is Creoline. This can be secured at any drug store and should be used in the strength of a teaspoonful in a pint of boiling water.

CASTRATION

In castrating animals on the farm it will pay in the long run to use soap and water and Creoline as an antiseptic freely over the scrotum before making an incision with the knife.

**CASTRATING
CALVES**

In castrating calves a good, sharp, clean knife is sufficient. Always make a long incision on the sides of the scrotum or cut off at least one-fourth of the same at the lower end. This is done to prevent healing too quickly and to secure good drainage. The cord should be scraped off high up. The castrating of calves should not be attended with the loss of a single animal if the operation is properly done.

**CASTRATING
COLTS**

The horse is very much subject to inflammation following castration, and the work should either be done by a veterinarian or an experienced castrator in the neighborhood. The secrets of success are, first, to have everything in connection with the operation perfectly clean; sec-

ond, to make incisions at least four inches long so as to secure perfect drainage, and, third, to cut the artery in such a way that there will not be excessive bleeding following the operation. The cord and artery should be removed two inches above the bulb. The easiest, as well as the most scientific way, is to cut off the cord and the artery at the same time with an emasculator, an instrument which every stockman should have, and which can be secured from any instrument house for \$6. This instrument will often come in handy in doing other farm operations, such as the removal of tumors.

CASTRATING SHEEP

The castration of sheep is attended with many difficulties. The scrotum of the sheep is so large that the inflammation following an operation often causes serious difficulty. A large part of the scrotum should be removed and the cords are usually pulled out. It is not necessary to do this with the teeth—the hand will do.

In the castration of all animals the clamps are no longer used, neither is the hot iron for searing the end of the artery. Tying the end of the artery with a string often results in a tumorous growth in the end of the cord, which has to be removed later. All animals that have been castrated should be watched, and if it is found that they are swelling badly after a few days, it will indicate that the opening of the wound has closed and that pus is accumulating above. In

this case, no matter whether it be the sheep, the calf, or the colt, you should catch and hold the animal and push the finger greased with cosmo-line up into the wound and free the imprisoned matter.

The swelling will usually disappear within a few hours after this is done. The colt that has been castrated should be exercised every day. The calf will seldom need any attention. In the case of sheep the long wool, which is likely to get into the wound, should be clipped off with shears at the time the operation is performed, at least if the animals are allowed to get too old before the operation.

CASTRATING PIGS

On the pig the operation is performed much the same as with the calf. There are seldom any bad results following the castration of pigs. The main thing is to make the opening low enough so there will be drainage from the bottom of the sack.

AGE FOR CASTRATING ANIMALS

In the castration of a colt the age should depend much upon the animal. Get that idea out of your head that spring is the only time to castrate animals. The time of the year makes no difference, providing the weather is good, your knife sharp, and the flies are not too bothersome. When a colt is well developed in the neck and shoulders, he should be castrated the spring following his birth—one year old. If the colt is

built more like a female, well developed in the hind quarters and not well developed in the neck and shoulders, he should not be castrated until he is two or possibly three years old.

Calves should be castrated any time from three months up, until there is danger of leaving them with the herd, which would be from ten to twelve months.

Sheep should be castrated when young, if you wish to avoid heavy loss. This will mean at from two to four months old.

Pigs are usually castrated when about four months old.

**BARBED
WIRE CUTS
AND OTHER
WOUNDS**

In the case of a barbed wire cut the first thing is to stop the bleeding. Don't get foolish and put on a lot of cobwebs, axle grease, cow manure, and such things that may result in infecting the wound and cause serious trouble. A clean bandage of white muslin, tied firmly around or just above the wound will stop the bleeding in a short time. After the bleeding has stopped the bandage should be removed, the ragged ends of all tissue should be clipped off, the clots of blood removed, and an antiseptic dressing applied. Do not keep the wound tied up, as it is impossible for you to keep it antiseptic. It is better to leave it exposed to the air. For a good dressing on a fresh wound any one of the following are to be recommended:

Carbolic acid in water; one to fifty.

Creoline, one teaspoonful to a pint of boiled water. The same for Zenoleum.

Corrosive sublimate tablets may be obtained at any drug store and used in water according to directions on the bottle.

As a dressing for a wound that is not fresh, peroxide of hydrogen in full strength, or diluted one-half with water is especially good. Common air-slaked lime, boracic acid and iodoform are valuable remedies. In fly time use some substance like chloronaptholeum to keep them away.

SEWING UP WOUNDS

A ragged barbed wire cut on the muscles or tendons of the legs is seldom sewed up with any benefit. The muscles tear out the stitches and in two or three days the wound is gaping open. Neither can a bandage be applied with any benefit.

Wounds in the fleshy part of the body should always be carefully sewed up, being sure to leave an opening at the lowest part of the wound to insure good drainage. In case of emergency, in the absence of a surgeon's needle and silk, a wound may be temporarily brought together with heavy cotton thread and a heavy sewing needle secured from the housewife.

FISTULA AND POLL EVIL

Fistula and the poll-evil are the same thing, only in different places on the animal. The treatment of this condition should always be left to a qualified veterinarian if possible. The poll-

evil is more difficult to cure than the fistulous withers or a fistula almost anywhere else on the body.

Remember this, that the secret of success is not in the reckless use of the knife or the injection of any one remedy that is specially efficacious, and it is only evidence of ignorance and a relic of the superstition of primitive man to recommend one particular remedy, as a cure-all for such conditions. The great secret of success, more than any other, is, no doubt, the securing of drainage from the bottom of the fistula all the time. This can be done by a large incision or by the use of setons.

The fistula must be faithfully attended if you wish to succeed. The farmer and stockman, even if he knows just how to handle these cases, usually gets discouraged and neglects them before enough time is given and failure is the result.

**SPAVIN,
RINGBONE
AND SPLINTS**

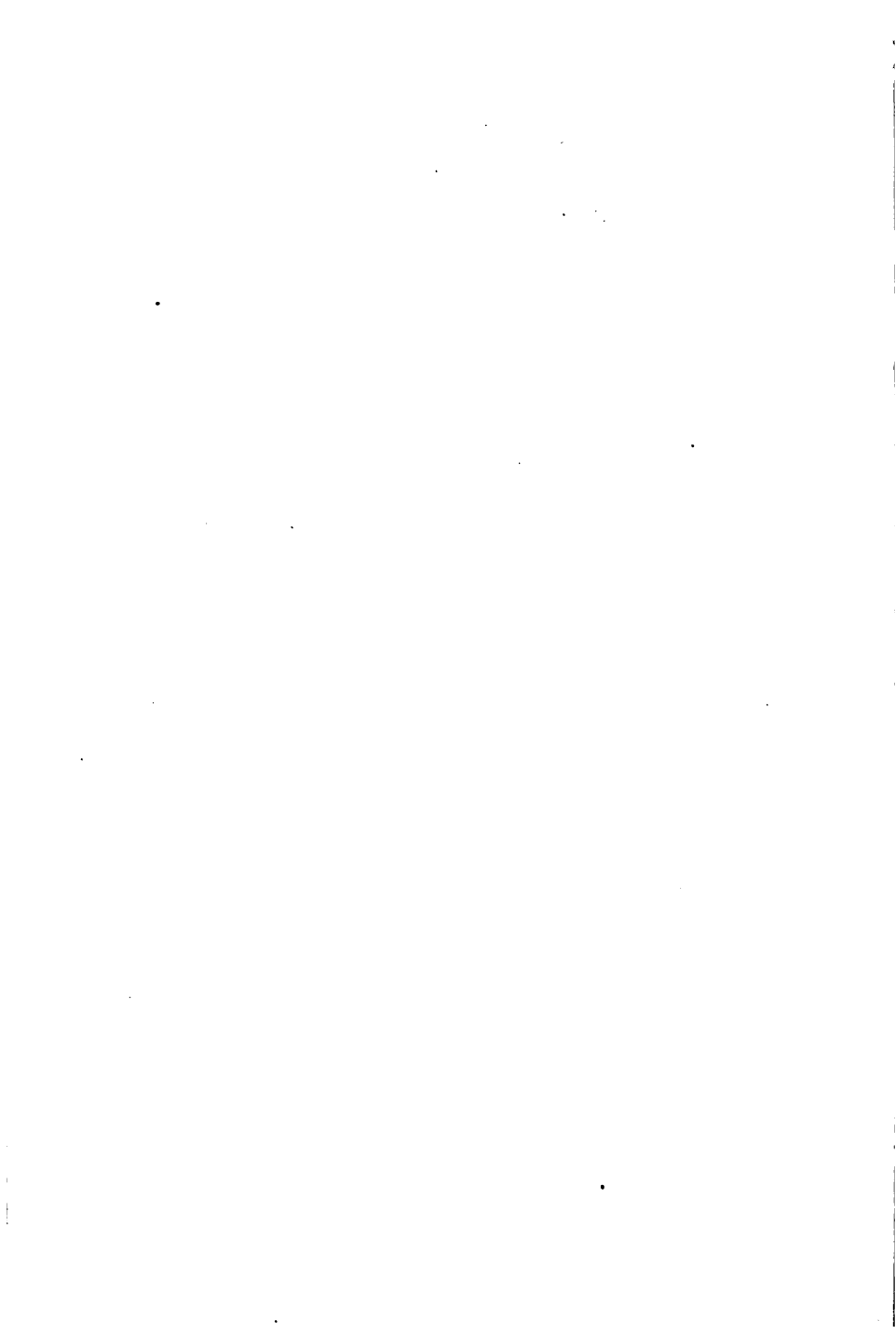
The farmer should remember that as long as he breeds animals with these troubles, just so long will he have colts predisposed to such conditions.

Spavin, ringbone and splints are the same thing, only found in different parts of the animal. They are incurable. Spavin and ringbone depreciate the animal about ninety per cent. The splint, in not being connected with the joint, usually causes only temporary lame-

ness. Blisters and other irritants are of benefit only as they hasten the process of bone formation.

THE TEETH OF THE HORSE

Next to the feet, there is no one thing of so much importance to take into account in the buying of a horse, as well as in his care, as the teeth. Remember, that the horse's food is not cooked, nor is it prepared for digestion. His grist mill must be in perfect order; otherwise, he will not thrive, no matter how much grain you feed him. The teeth of most horses are inadequate. The teeth of the ordinary horse at fifteen years are found to be uneven, or decayed—in such condition that the horse is hard to keep in his usual condition and flesh. Whenever you see a horse twenty-five years old still at work and in good condition you will find that nature has given him a good set of teeth. In buying horses it is always well to look at the teeth and take them into serious consideration before giving up your money. Two or three hours spent in smoothing down the teeth of a horse once a year will often save many dollars in the price of the feed.





Part VII.

HOME BUILDING.

*And now we've reached the final stage
Of entering our heritage.
On plateau, plain or mountain slope
We'll build a home with faith and hope.
We're here to stay, let fall what may
And building for a future day
When heaven within will still all fears,
When life shall ripen with the happy years.*



Plate LI. There Are Many Cozy Nooks Adjoining the Range. Photo by Stimson.

CHAPTER XXVI.

HINTS ON SELECTING A WESTERN FARM.

Many think they know much because they were "brought up" on a farm. Perhaps it was not a western farm. One who has merely learned to milk a cow may make mistakes in hitching up a horse.

GENERAL CONSIDERA- TIONS

The newcomer who would build a home in the West should remember that he is now meeting with conditions about which he knows nothing. So far as he understands the principles which underlie the science and practice of agriculture his education will be useful. What he may know about local practice and the experience which fixes his method of judging that some fact must be true here, because certain relationships make it true where he was raised, should be entirely forgotten and laid aside. The West establishes new relationships and new facts which are seldom what they appear to be.

The "tenderfoot" who would secure a farm in the arid region should have disinterested and expert advice if he has to pay for it. Not all land agents are the get-rich-quick kind. Those that are reliable act upon the realization that the success of the man to whom they sell land is of much importance to them. Such men know the first principle of all successful business, that fraud profits them nothing in the end. The

man who would buy land should select that kind of an agent.

**DISTANCE
FROM
RAILROAD
TRANSPOR-
TATION**

The arid West is a big country. It is a land of grand and magnificent distances. The arid rancher thinks nothing of traveling fifty miles one day to attend a dance given by a neighbor and go back home again the next day. The climate, the roads, the horses, make fifty or seventy-five miles a day merely pleasure excursions. The man who is going to locate a farm, however, will give this matter of distance his earnest attention. If he is going to raise cattle, horses, or sheep, and can walk all he produces to market, the distance from a railroad is of less importance than securing conditions of ranch and range most suitable to his stock. The farmer who would raise grains for market or who produces stock feeds, and makes the feeding industry the main part of his operations, should not ordinarily locate more than ten or twenty miles from a shipping point. The pure farmer who raises sugar beets, potatoes or fruits, will generally find it unprofitable to haul his products in wagons more than four or five miles.

**WATER
SUPPLY**

The nomadic sheepherder and his flock will thrive through the winter on waterless deserts, if there is even a limited snow supply. The home builder must have water. The rainfall is not sufficient in amount or constant enough

in supply to enable the settler to catch water from the roofs of his buildings for storage in barrels or cisterns. He must depend on running streams or underground supply. If range or pasture is secured, a constant and sufficient supply of stock water must be provided. The man who buys an irrigated farm should investigate the supply for this purpose and his right and title to use that supply. The dry farmer will also be concerned with his soil reservoir and the possibility of practical conservation.

EXPOSURE

There are no sections of the West, where domestic water can be secured, that are not inhabitable. There are vast differences, however, in exposure and its effect on the kind of crops raised or the general comfort of man and beast. Protection from winds, from storms, from snow drifts, either by natural lay of the land in relation to the force and direction from which storms come, or by artificial wind breaks, should be taken into consideration. If there is no air drainage, late and early frosts may be annoying. If there is not good soil drainage, there may be accumulation of alkali in irrigated districts. The influence of mountain ranges is marked and usually nearness to the mountains or hills secures most favorable climatic conditions. Never put the house or stable in the bottom of a dry gulch. The agency which formed these gulches may simply be sleeping for the time and

the time may be long enough so the place has no appearance of a water-course. A water spout or sudden melting of snow may show you how the place happened to be there. Too often men ignore both climatology and the force of gravitation.

A STOCK RANCH

Distance from market is a secondary consideration. There must be water for stock and man. Take into consideration the character of the range. Is there range enough? Is there summer and winter range so stock may alternate and give each section of grass an occasional rest? What is the character of the forage? Is there grass for cattle and horses or a variety of browse for sheep? Are there areas on this range covered with poison weeds which cannot be avoided at seasons of the year when running stock on them would occasion loss? Are there forest reservations, where pasture can be secured a part of the year? Are there school or other state lands that can be leased? Is the range an open one and already fully occupied?

Take into consideration the arable land. Are there native meadows which can be irrigated for the production of winter feed? Are there areas where more concentrated stock foods, like grains, alfalfa, peas and root-crops can be raised in sufficient amount?

In looking over all the advantages do not fail to consider the "drawbacks." There may be im-

portant advantage in high altitude; in growth and quality of grass and forage; and in climate favorable to the feeding of stock. Range stock from some of these high mountain or plateau ranches brings full price of corn-fed meat. If a place is suitable to a certain kind of stock do not try to force profits out of raising something for which it is not so well suited. What are the conditions of climate? There may be blizzards or cold, wet spring storms, which must be prepared against. Other things may suggest themselves to the man who wants a stock ranch. Many of his considerations will be those of personal taste, and there is much opportunity in the arid region for men to control their conditions and build without interference of natural forces.

A DRY FARM

There are great dry farms in parts of the West where grain raising is the principal industry. Such products may be hauled some distance to market and if stock raising is combined with crop production, nearness to town may not be a very important consideration. In selecting a dry farm, give weighty consideration to three things. First, can good domestic water be had? Second, is the rainfall (including snow) sufficient for profitable crop growing? Third, is the soil such that this moisture can be successfully stored for the use of the crop and will this soil be productive.

The new dry farmer must get much of his information from the experience of those who have been growing crops. He need not necessarily listen to the "oldest inhabitant." Unless the local man has honestly tried out an advanced method, he is unacquainted with the possibilities of his own country and may be loaded up with prejudice. Some of the Western States have established dry farm demonstrations and all of them have Government Experiment Stations. From either of these sources the newcomer may obtain reliable information of methods and possibilities in any particular region so far as they are known. There are considerable areas in the West which are suitable for dry farming that are already in private ownership, but undeveloped. Alternate sections of railroad lands within the land grants have largely been purchased by stockmen for range purposes. Some of the government land in these grants and elsewhere have become titled lands under the several land laws. Other areas are still open for entry under the homestead acts. Any man who wishes to build a dry farm home, should secure not less than a half section and combining more land than this with his stock industry will bring greater prosperity. Economic conditions call for large dry farms as insistently as they demand small irrigated farms.

**SELECTING
AN
IRRIGATED
FARM**

Purchasers of western homes will find two conditions of irrigated farms. First, those which have been irrigated and developed. Second, raw lands for the reclamation of which irrigation works have been or are being constructed. No advice is needed by the man who is going to buy a developed farm, save the general advice not to buy more than he can work and manage with the greatest profit, and to understand the nature of his water right.

To the farmer who would acquire title to new land under private ditches, Carey Act projects or Government reclamation enterprises, much more should be said than the limitations of a brief chapter permit.

The most happy, prosperous and quickly developed homes may be, and are, built in the arid region by and thru the use of our perennial water supply. Since the early days water has so increased in value that permanent water rights are often cheap at thirty dollars to fifty dollars per acre. One who pays these prices for his water rights should use judgment in the selection of the land. There are few poor lands and practically none which will not produce crops. Some are far more suitable than others for certain intensive culture crops. There are potato soils, sugar beet soils, grain soils and fruit soils.

**GEOPHYTICS
—OR CHAR-
ACTER OF
SOIL TOLD
BY PLANTS**

For many years the writer has seriously thought of calling attention to a new science for the West and calling it by some mysterious word not found in the dictionaries. This science would classify different characters of soils by the kind of native vegetation they produce and also according to the classes of crops which could be best grown on them. For example, as we indicate elsewhere, scientists are now finding out that there are potato soils in the West and soils that are not potato soils. Again, experienced western farmers know at once from the appearance of the native plants growing on a soil whether that soil would be suitable when reclaimed for crop production. We show that poverty weed grows on a soil without aeration and tith. It is a common expression that soils which will grow "black sage" are good soils—soils that grow gramma grass and cactus are easy soils to work—soils that grow grease-wood are strong soils, but sometimes difficult to bring into high production. Certain plants, like drop seed grass, salt grass, salt sages and others grow on soils rich in alkali salts and the kind of plants indicate the character of the alkali. This is true in an important and highly practical way and may be made use of by the man who is selecting land for a farm. The underlying principles of this science have not been worked out but its application is apparent and useful.

**WATER
SUPPLY AND
WATER
RIGHTS**

The water supply in most sections of the arid region is limited. There is more land than there is water. The water is the valuable asset—the land is practically thrown in. There are different laws in the different arid States governing the appropriation and use of water. The new settler should become familiar with these laws. He should satisfy himself in regard to the water available for his use and know that he has a right to that use which will be protected. The laws in some States provide that the waters of the State belong to the State; that the water belongs to the land for which a decree of appropriation is granted; that this water can only be used on this particular land, and that there shall be no monopoly of or bartering and speculation in water for irrigation. The principle of right by prior appropriation is maintained and the new home builder should be acquainted with the significance of these laws.

**THE LAY OF
THE LAND**

Some lands are so rough or rolling, or steep, or flat, or hard, or leaky, that they can never be profitably irrigated. Here, as under dry farming, the manner in which the soil will act toward water is important. Some soils break up into a loose dust that will be carried away by water; others may dissolve like sugar or salt and others may swell up or sink. Of course these soils are rare and seldom occur over any extent of surface, but the discriminating buyer will try to know

what per cent. of his soil is good or bad. Soils that have been formed by rivers that have washed the materials long distances, are apt to be spotted. There may be gravel beds, sand beds, clay banks or river silt. The winds may have shifted the sands into dunes. Usually spottedness in new soils will show plainly in spotted crops for a year or more, but after a few seasons of cultivation they become tamed alike and the crop will be even in stand, growth and time of maturing. Land and water are so valuable that it often pays to level down small hills and smooth up comparatively rough land to put it in condition for irrigation.

The points we have suggested in regard to soil drainage and air drainage, are important in selecting an irrigated farm. Where dairying or special crop farming is practiced, the land should be practically near a town or station.

SUPPLE- MENTAL FARMING

By supplemental farming we mean the combination of dry farming with the irrigated ranch, or the use of small or irregular water supply for irrigating a garden or other portion of a dry farm. There are many locations where a good home could be built and where neither the irrigation farming or the dry farming would be successful alone. There are many others where such combinations would complete the system and be highly profitable. This system has not been given the notice it deserves. We believe it

a most important consideration. The man who would select this kind of farm will make the most of his dry farm soil or of his opportunities to irrigate by the pumping of water, or catching flood water in small reservoirs or by winter irrigation.



Plate LII. Grand Mountains Add Beauty and Become Personal Friends.

Photo by Stimson.



Plate LIII. These Improvements Are Modest and Neat with Trees and a Garden. Photo by Stimson.

CHAPTER XXVII.

STARTING A WESTERN FARM HOME.

A home is not builded in a day. It takes years and decades for the fruition of hope and to establish heart and soul associations between men and materials.

CONSIDERATIONS OF CASH CAPITAL AT HAND

Few men who attempt to build a home are supplied with enough capital. Whether a man without any capital will succeed depends entirely on personal qualifications. One man with nothing, under most trying circumstances, will accumulate an independent fortune. Another man with apparently sufficient money, will starve out and move on. It is a question of temperament and management.

The average man has a limited bank account. He must husband and use it in accordance with natural principles of economy. We deplore stinginess. Penuriousness runs into error and often causes loss which defeats itself, while a generous liberality of heart and soul, balanced by intelligent management, results in accumulation and happiness. It may not be wise to suggest that a man should not attempt to secure a home unless he has sufficient cash. If he has a family he certainly should have enough means either in money or credit to make his first payments, secure his necessary equipment and provide living two or three years before he can be

certain that the land will sustain him. The active development now going on in the West insures that an industrious man can always find something to do at high wages, and many work out one-half the year, in order to get means to develop their homes the other half year. As a general rule a man should not attempt more than forty acres to eighty acres under irrigation. More money is made by proper intensive cultivation on the small farm unit under irrigation. No return should be expected from the land the first year outside of garden or feed for home use, and maintenance of cow and work animals. A prevalent fault with most men who become enthusiastic over a new country is an uncontrollable desire to own all of it.

**FRUGAL
BEGINNING
MAKES FOR
PERMANENCE**

The new farmer should be willing to pioneer for a while. He should rough it and build slowly. At first put as small outlay as possible in *dead* stock—those things which will give no cash return from use of capital employed. Make the *live* stock part of the investment as good and permanent as possible. By “live stock” we mean all those things which will give returns, whether they be pigs, chickens, soil culture or crops. It is stock in trade. Buildings for first occupancy of man or animals may be temporary and cheap. In the West none need shun the outdoors. Night air is as healthy as day air—there is no danger

in drafts—there is no swamp miasma or disease-breeding mosquito from below and comparatively little wet from above. However, personal comfort should never be neglected. It is your main stock in trade—the chief element of your success. First make yourself and family comfortable. Then let your income improve your improvements.

**FAMILY
COMFORT
FIRST**

The family comfort depends mainly on three things—a warm house, though it be small, a good and convenient water supply, comfortable and sanitary convenience for waste—house, well, closet.

**THE TENT
HOUSE**

It is possible to get along with considerable comfort the first season in well constructed tent-houses. A good tent, stretched over a frame work, with floor inside and banked up outside with soil, will be found habitable. A house tent, however, should have a fly over the top, and where the winters are cold or windy, a double wall will pay.

THE DUGOUT

Where there is good drainage or a side hill is available, a dugout may be constructed which will do for temporary occupancy. Such dugout may be covered over the top with timbers, boards, building paper or tar paper, and four or five inches of soil. The average American will not

take kindly to this idea. Many have to learn that there is no disgrace in frugal beginnings for a high and honest purpose.

**THE SOD
HOUSE**

In many places on the Western plains, it is possible to cut good heavy sods to use for build-



Plate LIV. These Sod Houses Are Comfortable.

ing material. Such sod should be cut a foot or more wide, from one to three feet long, and as thick as the grass roots will hold the soil together. They may be laid up like bricks. The roof should be made with generous eaves which will carry the moisture far enough over so it will

not drain down the sides and wash away the walls.

**ADOBE
HOUSE**

Clay soils may often be found which will mix with straw, brush, gravel or other materials and can be used to construct a wall by pouring muck into molds. The mold may be simply a plank placed on each side, the mixed muck poured and pounded in between, and the planks raised as the wall is builded. The same kind of roof as that used for sod houses should be put on. Houses built in this way are warm and in our dry climate last for many years. A good tight roof can be made by laying timber across the walls and bending boards over them to make a curved roof, which need not be steep. Over these boards place a tough fibrous building paper or tar paper and then lay on four to six inches of soil.

LOG HOUSES

Where timber is available or if one can reach the Timber Reserve and use the dead trees, log buildings can be constructed with little money outlay. Buildings of logs are very comfortable if properly made and chinked. Where sawed timbers can be obtained they make one of the easiest constructed and best house walls. We do not need to suggest methods of building with lumber, for where lumber can be obtained, every man will be able to work out his own building problem.

**DOMESTIC
WATER
SUPPLY**

The second of our three essential elements of comfort is water. The first thing the new farmer should do is to develop his water-supply. If he has any money left, it may be put into buildings and other things. Too many new farmers leave this until the last, and haul water so long that they use up more valuable effort and time, many times over, than the first cost of a home supply would amount to. No man should begin to haul water if he can avoid it. Water is a necessity to drink and an occasional rotation of the water bath with the dust bath, in season, is not altogether a luxury. Over most of the arid region well water can be obtained. In many sections there are artesian basins, and wherever a deep well will secure a supply of water which is uncontaminated with surface drainage or with alkali, deep wells should be bored. Some scheme for power pumping is generally an economy on the farm. In much of the arid region there is sufficient wind movement to make windmills practicable. In other places the gasoline or a hot-air engine is more advisable. It requires a comparatively small outlay to establish a pump and power. Either a tank above ground or a pressure tank underneath should be installed to furnish a supply of running water, both in the barn yard and in the house. With a pressure tank the farmer can have his hot and coldwater and bath in the house, a sprinkler on the lawn, and a supply of water on tap wherever needed.

**SANITARY
DISPOSAL
OF WASTE**

Our third element of comfort is the sanitary disposal of waste. The farm house should have its drain from the kitchen and a cesspool, if there is no other means of disposal of waste water. On the dry farm do not waste the waste water. Use it on the garden. Every farm house may have a sanitary closet. If water pressure is not available and the water closet can not be installed, which is usually the case on new farms, the soil closet may take its place. For some reasons the soil closet is the most economical and best. There is no greater deodorant and disinfectant than dry soil, and in parts of Europe soil closets are used in the best houses. The soil closet enables the farmer to save the last element of fertility which is usually wasted. His night soil can be placed in the garden or where it will do the most good. The soil closet may be built in the form of the ordinary privy, making a box in the shape of a drawer which slides underneath the seat. This box should be placed on two-by-four runners with a clevis attached, so a horse can haul it away, to be dumped. The seat above should be on a hinge so that it may be lifted. A box of soil should be kept at hand and plenty of it used every day. Such closets are free from smell and from disease germs, clean and comfortable. They may be placed near so it will not be necessary to make long journeys through storm and mud. They should be tightly enclosed so they will be comfortable.

**OTHER
BUILDINGS—
BARN**

In the West it is not so necessary to house stock in the winter as it is in the more humid sections. A barn or stable may simply be made convenient for the handling and feeding of stock. A cheap, warm, and efficient barn may be made out of baled straw. The roof should be supported on posts and may be made of timbers which will support a quantity of loose straw or of shingles or galvanized iron. New farmers often build their barns by setting posts and stretching wire on both sides, filling in between with loose straw. In many places bailing wire is abundant, and the only cost of such buildings is the work of constructing them.

**POULTRY
HOUSE**

The poultry house should be so built that the chickens or turkeys can be inclosed at night to save them from coyotes and other animals. It is important to have the poultry house warm in winter. It may be banked with straw or soil. Usually there is no more profitable thing on the farm than winter-laying hens.

HOG HOUSE

Every farm should have its pig-pen and pig shelter. One of the cheapest and best pig shelters is a board house, made in the form of a letter A. It is constructed with sixteen-foot boards, cut in two, slanted from the ground to the peak, making a house eight feet square on the ground and as high as eight-foot boards slanted in this

way will reach. The ends are covered, with the exception of a door, which may be left open. The cracks should be battened and a small opening for ventilation left near the peak of roof on the side opposite the door. This is a good house



Plate LV. The "A" Hog House.

By Permission Colo. Agrl. College.

for brood sows, as the slanting roof will give room for young pigs and prevent the mother from lying on and killing them. The house may be moved to the alfalfa pasture in the spring or summer and placed in the barnyard in winter. To build this pig house requires one hundred

and eighty feet of sixteen-foot boards, two two-by-fours sixteen feet long, about eighteen battens sixteen feet long, a total of three hundred square feet of lumber and ten cents' worth of nails.

GRANARY

Nearly every farmer will need a granary and a root cellar for storing crops. It is necessary to secure lumber for building the granary. We would merely suggest that it is better to store grain in open bins than in sacks, because there is less damage from mice or chipmunks.

**ROOT
CELLAR**

The root cellar may be built entirely under ground or on top of the ground. Where potatoes are raised in quantity large root cellars should usually be built on top of the ground with double doors at each end, and a driveway so a wagon can be driven through. The roof of the root cellar may be of timbers, brush, straw, and dirt, from one to two feet of covering being required in the Northern region to keep out the winter frost. There should always be one or more ventilators in the roof; the double doors should be made as tight as possible. It may be necessary to watch the root cellar every day in cold weather. Have a thermometer and do not let things freeze if you find it necessary to carry in hot ashes or build a fire.

**FENCING
THE FARM**

The new farmer usually makes costly mistakes in his fencing. A good fence is good econ-

omy. The time is coming when a ranch or farm will not be considered one unless fenced with woven wire, or something else equally as good. Barbed wire is the material usually used. Not less than three or four strands of barbed wire should be used. A poor fence teaches stock to be breachy, and causes loss by the stock getting tangled in it and being killed or injured with wire cuts. One of the most important problems met with in the arid region is the securing of suitable fence posts. Over much of the region pitch pine, white pine, cedar, cottonwood, or willow posts may be secured. Posts made of iron pipe set in cement are sometimes used. Cement posts are now being made, but they are usually too expensive for the new-comer. A good reinforced cement post costs from thirty to fifty cents.

TREATMENT OF POSTS

As posts of some kind of timber are ordinarily used, it will be found advisable to treat them to increase their length of life. An ordinary, dry cottonwood or spruce post placed in the ground will rot off in two years. Posts made of mountain spruce are very short-lived. Pitch-pine or cedar posts will last from ten to fifteen years when set in the ground. Many ranchmen who have land to spare build buck fences. The bucks are made by setting a post at an angle of from thirty to forty-five degrees, supporting them with one or two sticks used as props set in

holes bored near the top of the post. Such bucks of pine merely rot off slightly at the bottom where they come in contact with the ground, and get about four or five inches shorter in twenty years' time.

Many methods of treating fence posts have been devised and recommended. Most of these methods, such as treating with creosote or corrosive sublimate require the use of large tanks and careful attention to the proper recipes. In experiments carried on by the author in treating pitch pine posts, he found that the life of the post was indefinitely extended by the following treatment: Paint or dip the lower end of the post a little higher than it is to go into the ground with crude petroleum. Place in small piles of half a dozen posts and burn off the petroleum. Do not let burn too long. They should get hot enough to force the oil into the wood and produce a slight blackening on the outside. Posts treated in this way seem to be so well protected from dry rot that they will last many times as long as untreated posts. The treatment costs but a few cents for each post, and saves both in cost of renewal and the work of building new fences.

GATES

The ordinary barbed wire gate is an abomination and an expensive nuisance if where it must be used several times a day. To make a good gate out of timber and swing it on a post

will cost little more than the wire. Automatic iron gates can now be obtained. The best ones are those which swing and are operated by toggles worked by the wheel of the wagon. Such gates open and close automatically, save the farmer time, prevent runaways, and generally give such satisfaction that the increased first cost is not regretted if a man has means enough to afford good improvements.



Plate LVI. A Full Set of Buildings with Young Trees and Garden. Photo by Stimson.

CHAPTER XXVIII.

THE HOME GARDEN.

The man who has always lived in a large city does not know what wholesome eating is. Had he possession of unlimited wealth he could not buy freshness.

WHAT THE GARDEN DOES

The garden is the small piece of intensively cultivated ground which no home, wherever it may be located, should be without. This garden may be a tomato can growing a single plant or it may cover an acre. It may be for beautifying a place by raising decorative plants or it may be used to supply the principal living for the family. It is this latter kind of garden that fits into the necessary economy of the successful farm. The garden supplies genuine food. It is pure food. No other food can take the place of or excel fresh garden truck. This food, raised at home by the application of a little time and labor, brings more happiness and thrift per square rod than the rest of the farm does per square acre. It furnishes sustenance and cheapens the cost of living. The garden, the cow, the hen and the pig are home economies which furnish a living unexcelled, and the farmer who husband his resources and saves money in these several ways, never fails.

It has been the gardeners of the West that

have demonstrated our larger agricultural possibilities. Could the large rangemen have prevented the planting of gardens they could have undisputed possession of the arid region forever.

The garden displays the richness of the soil, the suitableness of the climate, the results of intensive culture. The closer study given plants and their relationships in the garden give clearer insight into the underlying principles of soil and plant culture. Its educational value is no small part of the profit of a garden. A well-kept garden gives a keen and lively interest in plant life and in the advantages of the new country to every member of the family, and may be shown with pride to visiting friends. It inspires hope and confidence in future prosperity.

HOW TO MAKE A GARDEN

Plant a wind-break along the border of the garden, generally leaving it open to the South to receive the most sun. Thicken the wind-break with Boxthorne or Honey Locust hedge. Put in a row or two of apple trees, and cherries, currants and gooseberries, and dwarf mountain cherry. These things are hardy and stand drouth. Fertilize with forty to sixty loads of manure per acre. Use sheep manure if you can get it. Disc the manure into top soil and then plow deep and harrow until the best possible seed bed is obtained. Do this even if the garden is only a few rods square. Plant all garden stuff in rows far enough apart so cultivation may

be done with a horse. Small plants may be sown in double rows with two feet or more between for horse cultivation. •

**THE DRY
FARM
GARDEN**

The best results will be obtained where the moisture may be conserved for a season before planting, but do not wait to do this. Have some kind of garden the first year. Plants that will stand a great amount of drouth are Horseradish, Rhubarb, Jerusalem Artichoke, Tansy, Beans, Pop Corn, Sweet Corn, Potatoes, Peas, Summer and Winter Squash, Pumpkin, Asparagus, Winter Onions, Tomatoes, Salsify, Beets, Carrots, Parsnips, Rutabegas. These have been named somewhat in the order of their drouth-resistance. The only suggestion needed here is to make the soil rich, not filled with too much loose material, which will cause it to dry out, and keep the soil cultivated and aerated to save moisture, prevent weeds and make the crops grow. General directions for planting, and amount of seed are given on seed packets and in garden catalogs.

**WATER
WHERE
POSSIBLE**

In a press bulletin of the Colorado Experiment Station, J. E. Payne gives the following advice to dry farmers: "Plant a garden. If you have no well, plant a small plat near the house and water it with the waste water. Bury every drop of waste water beside some vegetable by making a furrow beside the plants and after the water has sunk away fill the furrow with dry

dirt. Old tin cans sunk in the ground by the side of hills of cucumbers aid in watering them economically. Punch holes in the bottoms of the cans."

"If you have a well, plant a large garden, but plant all garden stuff in rows so that it may be cultivated with horse power. Use the water with the same economy that you would if using only waste water. Never flood the ground purposely. If any should be flooded, stir it thoroughly as soon as it is dry enough."

"It is a common mistake with beginners in irrigation to try to make water take the place of cultivation. The result is failure. Another common mistake is to plant a larger area than can be watered from the well. Better begin with only a few square rods and extend the area as experience dictates.

* * * By planting the following seven varieties of sweet corn on the same day—and often near the last of May—I have had roasting ears from July 26th to September 26th. The varieties were Cory, Black Mexican, Perry's Hybrid, Stowell's Evergreen, Country Gentleman, Mammoth Evergreen and Egyptian. The large varieties may be dried for winter use or allowed to ripen to be used parched. Parched sweet corn is a luxury, but one which is in the reach of the poorest settler. White Pearl and Queen's Golden pop corn have done well for me,

and my family have had many meals consisting of whipped cream and popcorn."

**THE
IRRIGATED
GARDEN**

There is no necessity of giving detailed instructions for irrigating each of the garden vegetables. In general, furrow irrigation should be practiced. The garden plants should be grown in rows wide apart and watered in furrows deep enough so the top of the rows are never under water. Quick and frequent irrigations followed by careful cultivation is the secret of greatest success. There are a few plants, notably the onion, which seem to give larger crops if flood irrigated. The onion bed may be surrounded with furrows or levees from six inches to a foot high and irrigated by filling with water. Unless there is good, quick-acting under-drainage, the water should be drawn off the bed after standing a couple of hours.

Plants which require and stand the most water are celery, cabbage, cauliflower, radishes and turnips. Such things as spinach, lettuce and melons need frequent irrigations and cultivations to keep the soil moist and warm.

Often where water is scarce a garden may be irrigated by catching a bank of snow in winter or by winter irrigation, or by catching the flood water from sudden storms or melting snow. Flood water may be stored in a small reservoir, and if it supplies only one light irrigation it will pay. Methods of dry farm practice to store moisture in the soil are always valuable.

**SOME
SIMPLE SUG-
GESTIONS**

Many things may be easily done to aid plants in their growth and usefulness by simply taking serious thought and doing them the right way. Knowing the origin or the little freaks of character in plants often gives us a clue which will help us make them do their best. As examples, beets came from the salt sea side, peas from the North, celery from the swamp, alfalfa from dry regions. Beets will stand alkali—peas a short cool season—celery wants wet feet—alfalfa will drown if its feet are kept wet. The way the sun and wind strikes the furrow makes a great difference in the little local climate immediately surrounding the plant. At low altitudes, where the sun is hot, such things as garden peas should be planted on the north slope of the furrow to keep the young seedlings cool. Melons and cucumbers may be planted on the south side of the furrow to keep them warm. Always set young cabbage, cauliflower, or celery plants on the north side of the furrow so they are protected somewhat from the hot sun rays. Tomatoes should be planted in deep furrows, which are gradually filled up, making them deeper rooted than if planted at the surface. These directions are suggestive of others that the thoughtful gardener and farmer may apply.

**PROTECTION
FROM FROST**

Much security from damage to garden truck by late and early frosts may be had by very simple means. One of the best protections from

frost is water. If there is frost indication, run water through the furrows in the garden or orchard and the latent heat it will give out is often an effectual saving of the crop. A simple and effective prevention of damage from light frosts is to thoroughly sprinkle the plants with a sprinkling pot or spray pump. It takes much frost to freeze plants when they are wet. We have seen water freeze into solid sheets of ice on the leaves of sweet potatoes and tomatoes without injuring the plants in the least. Usually, if plants can be saved at the time of the first fall frost, their time of usefulness is extended some weeks. When the garden does freeze, save all the green tomatoes, cantaloupe and other products by piling them up in piles or putting under a shed. They will go on ripening and those not used by the family make excellent feed for the cows and pigs, and other stock. If sweet potato vines are frosted, cut them off at once at top of ground. The roots may be left for later digging.

**MAKING THE
SEASON LONG**

Much may be done in places which have a season too short for certain tender vegetables. A good melon crop may be matured by protecting early planted hills during cold days, or at night with glass-covered boxes. Place a common sheet of window pane, 12x14 inches in size, at an angle of forty-five degrees, on top of a box made of one-inch boards, and set over the melon hills

in the spring with the glass facing the south to catch the sun. Take them off during the warm parts of the day to allow the plants to get air, and to dry off any accumulated moisture. Sometimes the soil may be made several degrees warmer in the spring by rolling with a smooth roller. Break it up again with the harrow in a few days to save the moisture. The suggestions here made along with suggestions for protecting from frost, enable us to grow more tender plants and keep them producing a longer time.

CHAPTER XXIX.

TREES.

The man who grows trees where none grew before has accomplished something worth while.

SHOULD THE DRY FARMER PLANT TREES?

Everyone loves trees. Few progressive men will be satisfied to build permanent homes without securing the association of trees. They add more to man's comfort and welfare than can be told in a small book. They make his landscape. They delight his eye. They provide shade and shelter. They furnish music and company. They supply wood and fruit.

There is no place where trees cannot be made to grow if they are given the right treatment. Unless they can be properly cared for do not attempt to grow them. Neglect will result in greater expense and loss when dealing with trees than any farm dissipation we know about unless it is fast horses. Be sure you are right—make haste slowly—proceed deliberately and with consideration, and good results are sure to follow. No attempt is made to give instruction relative to fruit growing or general horticulture, but the following brief recommendations should be followed by every farmer who expects to set out trees, whether he can irrigate much or little or not at all.



Plate LVII. The Old Cottonwoods Lend Shade and a Picturesque Beauty to This Ranch.
Big Horn County, Wyoming.

Photo by Stimson.

**PREPARA-
TION OF SOIL
FOR TREES**

Do not attempt to plant trees the first year in sod ground. The land should be plowed deeply, preferably in the fall, and summer tilled one year to conserve moisture. No weeds should be allowed to grow or mature. In digging holes in which to set the trees make them large. Throw the top soil in a pile by itself so that when the trees are set this top soil can be placed immediately around the roots. If there is hard-pan or any impervious sub-soil, it is a most excellent plan to put in a charge of dynamite wherever it will do the most good. In setting trees or shrubs close together, as for wind-breaks or hedge, much time and labor may be saved by plowing a deep furrow and running the sub-soiler sixteen or eighteen inches deep. This loosens up the ground and makes digging the holes easy. A good preparation of soil for trees is to sow alfalfa, sweet clover, field peas or other legumes, and plow under the crop to increase the humus in the soil. It is a good practice to use an old alfalfa field in which to set young trees, but the alfalfa should be plowed under before the trees have thrown out feeder roots through the surface soil.

**SETTING OUT
THE TREE**

Over the larger part of the arid region the only safe time to set out trees is in the spring. The killing back of young trees is largely due to their drying out. The long winters and drying

effects of the wind, while the roots are dormant, seems to be the main cause of killing back the tops of the tree. If trees or shrubs are obtained in the fall, they may be heeled in by laying lengthwise in deep trenches and covering the whole tree with enough earth to keep it moist. They should be taken out and planted where wanted as soon as the frost is out of the ground in the spring. If left in the pits too long, the buds will start and will be so tender when set out, that all will die back to the trunk and it will be necessary for new buds to form if the tree lives.

Deep planting should be practiced. Trees should always be put a few inches deeper than they grew in the nursery. We cannot tell just how far this system of deep planting can be carried with success. One dry farmer of many years' experience in Utah testifies that he planted poplar trees with four feet of the trunks beneath the surface of the ground. A deep trench was dug to get the roots down where they could reach some sub-surface moisture which occurred in that locality, and the trench was afterwards slowly filled level with the surface. He said these trees had been growing for many years. I would never attempt to set a tree without the use of water, even if I had to haul it in barrels. Set the trees in the hole, cover the roots with surface soil, tramp it down firmly and fill the re-

mainder of the hole with water. After the water has soaked away, finish filling the hole with soil and firm it well with the feet. If there is danger of winds loosening the tree, set one or two stakes and tie the tree to the stake with strips of soft rag. They should be watched, and if the trunks loosen an opening in the soil, tramp it tightly against the tree. If possible irrigate the trees from a canal or home water supply, but if this cannot be done, try one of the following methods.

**TIN-CAN
IRRIGATION
TO START
TREES**

When setting out the tree plant at a distance of eight inches or a foot from the trunk, a five-gallon oil can or other tin of like nature, putting it as deep as convenient in the soil. With a sharp awl puncture a very small hole in the bottom of the can. When the can is filled with water it will insure the soil around the roots remaining moist for a long enough period to start the growth of the tree. If water is convenient, a piece of stovepipe set next to a tree and the bottom half of it pounded full of manure, makes an excellent method of supplying water and at the same time stimulating with liquid plant food.

**ARTIFICIAL
ROOT
PRESSURE**

Some years ago Professor Goff, of Wisconsin, introduced a scheme of supplying artificial root pressure to start newly-planted trees. Experiments indicated that the method was very

successful. It is known that the sap in a growing tree exerts considerable pressure while the roots are absorbing water. When a tree is set out or transplanted, all the root hairs which absorb moisture are destroyed and new root-hairs must be thrown out before the root-pressure can be re-established.

The method of supplying this pressure temporarily is to place a can or bottle as high or higher than the upper limbs of a tree and connect it by a pipe or tube to the end of one of the freshly-cut-off roots at the bottom of the tree. If a pipe is used, connection between the pipe and the root is made with a small piece of soft rubber tubing which can be made tight so it will not leak. The can or bottle is filled with water and connection made when the tree is planted. This supplies both moisture and pressure, can be very cheaply done, and we suggest that dry-farmers who are planting trees under trying conditions give it a trial.

TEMPORARY PROTECTION

Some protection from the wind should always be provided. This may be done for each tree by wrapping the trunk with paper or setting a board on the side from which the prevailing wind comes. It often pays to provide shade for the trunks of newly-planted trees, and this is important in certain parts of the arid region. Some shade should be set on the south and west



Plate LVIII. Good Improvements with Small Cost—The Addition of a Few Trees Will Help.
Photo by Stimson.

sides to protect the tree trunks from sunscald, and if small evergreens are planted it is necessary to furnish some kind of shade the first season.

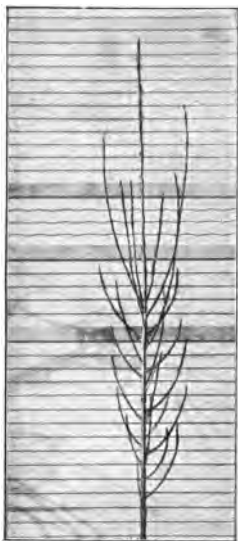


Plate LIX. A Good Way
to Leave the Top.



Plate LX. A Bad Way to Cut Back
a Tree Top.

**CULTIVATION
AND CARE
OF TREES**

Never allow grasses or weeds to grow close around the trunks of young trees. They use up plant food and pump out of the soil enormous amounts of water. Clean cultivation in orchards or tree plantations should never be neglected. Plowing around the trees forces them

to send their roots deeply into the soil, where they will not be caught by temporary drouth. During the season the surface cultivation maintains the soil mulch, saves the moisture, aerates the soil, warms it, fosters the bacteria and chemical action which makes plant food available and supplies the small feeding rootlets sent up from below with moisture and food. When the trees are first set out the tops may be trimmed back, but as a rule we would rather take chances on leaving most of the top, at least the terminal bud, as cutting them back often allows them to dry out and they recover slowly or not at all. If the top is to be trimmed back, merely trim the side branches or cut them out, and if any large branch is cut off, paint the wound with white lead. The best time to trim most trees is in spring or early summer. Do not cut off the limbs just before growth starts in the spring, because when the sap comes up, these fresh cuts will bleed and they furnish entrance places for insects and fungus diseases.

WINTER MULCHING

A mulch of three or four inches of barn-yard manure around each tree during the winter supplies plant food, saves moisture and prevents winter thawing of the frozen ground. Do not put such mulch immediately against the trunk of the tree, for it harbors mice, which may girdle the tree by eating the bark. Where standing

water gives a supply of ice that is convenient, mulching by placing lumps of ice around the tree has given most excellent results. This ice keeps the tree dormant, in a measure preventing the swelling of the buds too early in the spring, as well as keeping the soil from drying out. Some Northern fruit growers are practicing using the ice mulch and testify to its efficiency.

**KIND OF
TREES TO
PLANT**

The list of trees for general planting is a short one. In favorable locations and with protection a large variety of trees succeed. In towns and cities where there is protection afforded by many buildings, where the water supply is always available and the grower can give much attention to his trees, practically all the varieties that grow in like latitudes elsewhere will thrive. A good example of this may be cited in the trees of Denver, where the long list of varieties includes everything from the oak, linden, chestnut, walnut, horse-chestnut, etc., down to the ever-present and most hardy cottonwood.

**DROUTH-
RESISTANT
TREES**

As yet few trees have been injured to drouth. In the warmer parts of California the Eucalyptus thrives with little summer moisture. For the colder mountain and great basin regions the trees which will grow with least moisture are the common Pine, Englemann's Spruce, Norway

Spruce, Douglas Spruce, Box Elder, Green Ash, White Ash and Elm. While they are general lovers of water, there are none which are so sure to succeed on arid farms as the Cottonwood, Russian Willows and Poplar. Always plant the Cottonless Cottonwood. The Cottonwood is a native and so hardy that it succeeds with little moisture, where others fail.

The most drouth-resistant fruit trees are sour cherries and the more hardy apples. There are many producing orchards above irrigation where only the rainfall is depended on, of cherries and apples. The more hardy apples are among the hardiest of all trees.

**TREES FOR
HIGH
ALTITUDES**

Above 6,000 feet altitude on the plateau regions, plant only the Cottonless Cottonwood, the Willow and the Pine. In yards for ornamental purposes the Colorado Blue Spruce and the native Red Cedars will succeed anywhere if they can be watered. Hardy apples, cherries, and American plums succeed where any protection and care can be given them. The choicest hard wood trees are the Elm and White or Green Ash. The writer has seen splendid specimens of the Russian Mulberry, loaded with fruit, in a protected place about 7,000 feet altitude in Northern Colorado.

**KEY TO
TREES
WHICH WILL
GROW**

A partial list of the trees which are now growing successfully in the different sections of the arid region will indicate the known possibil-

ities. What has been done, can be done, and more is sure to be accomplished in the future. The following lists should be important guides to those who will plant.

**ALTITUDE
7,000 FEET**

At Laramie, Wyoming, the following list of trees are growing in the city: Cottonless Cottonwood, Native Black Cottonwood, Russian Willow, White Willow, Native Balm of Gilead, Quaking Aspen, Silver Poplar, Colorado Blue Spruce, Native Pine, Douglas Spruce, Tartarian Maple, Siberian Crab, Wealthy Apple, Dutchess Apple. All are irrigated. Wind breaks are necessary to make trees succeed.

**ALTITUDE
6,000 FEET**

At Cheyenne, Wyoming, all the trees named for Laramie are growing, and in addition we have noted the following: Horse Chestnut, Carolina Poplar, Honey Locust, Elm, White Ash, Red Cedar, Box Elder. Wind breaks are necessary.

**ALTITUDE
5,000 FEET**

In Northern Colorado are grown all the trees we have named for higher altitudes in Wyoming and in addition a long list might be added. We mention a few of the more desirable additions. Here, as elsewhere in the West, the more hardy Cottonwoods, Willows and Poplars are first choice for new planting. Any of this collection of trees should grow as well at the lower altitudes in Wyoming, Montana, Nevada, Idaho,

Utah and Western Kansas and Nebraska. Wind breaks are important for protection of young planting.

Carolina Poplar, Norway Poplar, Siberian Poplar, Lombardy Poplar, Elm, White Ash, Green Ash, Soft Maple, Cut-Leaved Birch, the Hardy Catalpa (*Catalpa Speciosa*), Honey Locust, Black Locust, Black Walnut, Hackberry, Horse Chestnut, Mountain Ash, Russian Mulberry, Russian Olive, Silver Poplar, Silver Maple, Norway Spruce, Box Elder, Black Cherry. The most hardy varieties of apples are Wealthy, Yellow Transparent, Northwest Greening, Peter, McMahan, Gano, etc.

**SOME OF THE
MOST HARDY
SHRUBS AND
VINES**

The following list of shrubs have proven to be hardy under the most trying climate and season. Flowering Currant, Native Gooseberry, Box Thorn or Matrimony Vine, Lilac, Bridal Wreath (*Spirea Van Houtteii*) Buffalo Berry, Silverberry, Choke Cherry, Native Roses, Tartarian Honeysuckle. The four most hardy vines are the Annual Wild Cucumber or Balsam Apple, native Hops, of which the roots live through the winter, Native Clematis, which is a very hardy perennial, and Virginia Creeper.

CHAPTER XXX.

WIND BREAKS.

Our winds are useful, but it is well not to get too much of a good thing.

GIVE THE WIND YOUR ATTENTION

Over the greater part of the plateau region and in eastern Oregon and Washington there is considerable wind movement. The windy season usually occurs during the spring months and while these storms are not destructive to property they greatly influence growing crops. In some places the drifting of soils is a factor that must be considered. The winds are dry and have much to do with the evaporation of moisture from soils and trees. These winds often carry along with them solid particles of snow, ice and sand, which may damage small seedlings of grains or other crops, and cause discomfort to stock. The value of brush and trees as shelter for stock is appreciated by many rangemen. There are some simple "kinks" in dodging the bad effects of winds that farmers may practice to their advantage.

SMALL WIND- BREAKS OF SOIL

In our soil culture talk we recommend the plowing and planting to be done at right angles to the direction of the wind. The rough furrows break up the force of the wind and prevent

the drifting of the soil. The small furrows left by the drill or the ridges formed by the harrow have the same effect and are valuable protection to seedling grains from the cutting effect of blowing sand and snow. In places the throwing up of small dykes or high furrow slices makes a wind-break which is worth while. Where the land is fairly level or smooth a low obstruction will cause the air that strikes it to be lifted so it does not again strike the land with force for considerable distances. Experiments have shown that an obstruction two or three feet high may be noticeable protection for a quarter mile beyond.

**TEMPORARY
PLANT
WIND-
BREAKS**

Three or four rows of tall growing corn, like the flour corn, which makes large growth, but does not mature in the north, or rows of Sorghum or Kafir corn, will make useful wind-breaks for young plantings. The stalks may be left standing thru the year.

A few years ago, in parts of Dakota, the Siberian wormwood was introduced. It is an annual sagebrush, which makes tall growth and the dead plants will stand some years. The Russian Sunflower planted closely and in double rows, would be effectual for one season. Many other annual plants which could be used for this purpose will suggest themselves to the farmer.

**PERMANENT
WIND-
BREAKS**

For permanent wind-breaks use quick-growing trees. Plant them thick in rows so the alter-

nate trees are opposite the space left in the next row. Set the rows at right angles to the prevailing winds on the sides of the farm from which the winds come. This will be on the West and North or Southwest and North sides of the place in most parts of the arid region.

WIND- BREAK TREES

At high altitudes nothing has been found to take the place of the cottonwood and willow. Evergreens, Pines and Spruce are promising, but have not been planted to any extent. At altitudes below five thousand feet in the middle West, the Carolina Poplar, is one of the most rapid-growing and successful wind-break trees. It is easy to plant and by heading back it throws out many side limbs from the trunks to fill in the space. Plant four feet apart in rows four feet apart, letting the trees alternate in each row.

The Russian and White Willows and Golden Willows make quick-growing wind-breaks, but are slower to start. These trees usually spend one or two seasons making roots and small side shoots before they throw up their central trunk. In many places, however, they will make thick wind-breaks from twelve to twenty feet high in four or five years. The Box Elder is a suitable wind-belt tree in many places, and a large number of other kinds will be useful. The Green Ash is one of the best drouth-resistant hard wood trees. The "Apple King" of Kansas says he plants apple trees for windbreaks and if he

wants more wind-breaks, he plants more apple trees. Such trees are dual purpose, furnishing both fruit and shelter. Where enough time can be used they will do. Such trees should be headed as near the ground as possible and allow soil cultivation close to the trunks.

**SHRUB OR
HEDGE
WIND-
BREAK**

Double rows of smaller growing hardy shrubs are both useful and ornamental. The hardiest and quickest growing is the Box Thorn or Matrimony Vine (*Lycium Vugare*).

Hedges may be grown of California Privet, Lilac, Honey Locust, Barberries, Willows or Osage Orange. Permanent rows of currants and gooseberries, Dwarf Cherries, Bush Honey Suckle (*Tartarian*), Buffalo Berries, and many others may be used. Some shrubs may be set in trenches placing them one to three feet apart and allowing them to thicken up. Where dry farming is practiced, some water should be used to start the plants, or moisture should be first stored by at least a year of tillage.

**SHELTER
BELTS**

Shelter belts several rods wide are often used and are advantageous where the winds blow long and strong. Such shelter belts are best composed of several varieties of trees. Plant the more hardy trees as Cottonwood, Poplars or Locust in the outer rows four or eight feet apart; then more compact-growing Box Elders or Green or White Ash. The Russian Olive is hardy and



Plate LXI. An Artificial Forest Shelter-Belt in Colorado.

may be worked in to advantage and rows of willows find a place in such plantings. Plant the inside rows closer together. A low trench left by furrowing with a lister or by back furrowing leaving the soil higher between the rows, will cause the moisture to run toward the newly planted young trees in the trenches. Shelter belts also catch drifting snows and are often more successful than single rows or narrow wind-breaks.

**COMBINED
WIND-
BREAK AND
FOREST**

In many parts of the West the growing of trees for commercial purposes is becoming profitable. In California, Eucalyptus plantations are grown for wood, and harvested in five or six years from planting. In parts of Kansas, Nebraska and Colorado, plantations of Catalpa and Black Locust are being set out for the production of railroad ties and fence posts. It is expected they will reach sufficient size in twelve to eighteen years. Some are even setting out black walnut groves for future lumber with the knowledge that there must be a wait of from fifty to eighty years to reap what has been sown.

Such timber plantations, if located with the object in view, furnish both wind-breaks and stock shelter.

**FENCE
WIND-
BREAKS**

Board, pole, log or brush fences are often used by range sheepmen to protect their flocks at night or during storms. Such fences make

effective wind protection for newly planted trees. Board fences constructed like the railroad snow fences, either supported on slanting "bucks" or on upright posts, cause eddies in the winds which will form snow banks where wanted and prevent deep snow drifts where they are not wanted. Not a few ranchmen use such fences to collect the snow for accumulation of moisture where they wish to grow their garden or some field crop.

THE END.

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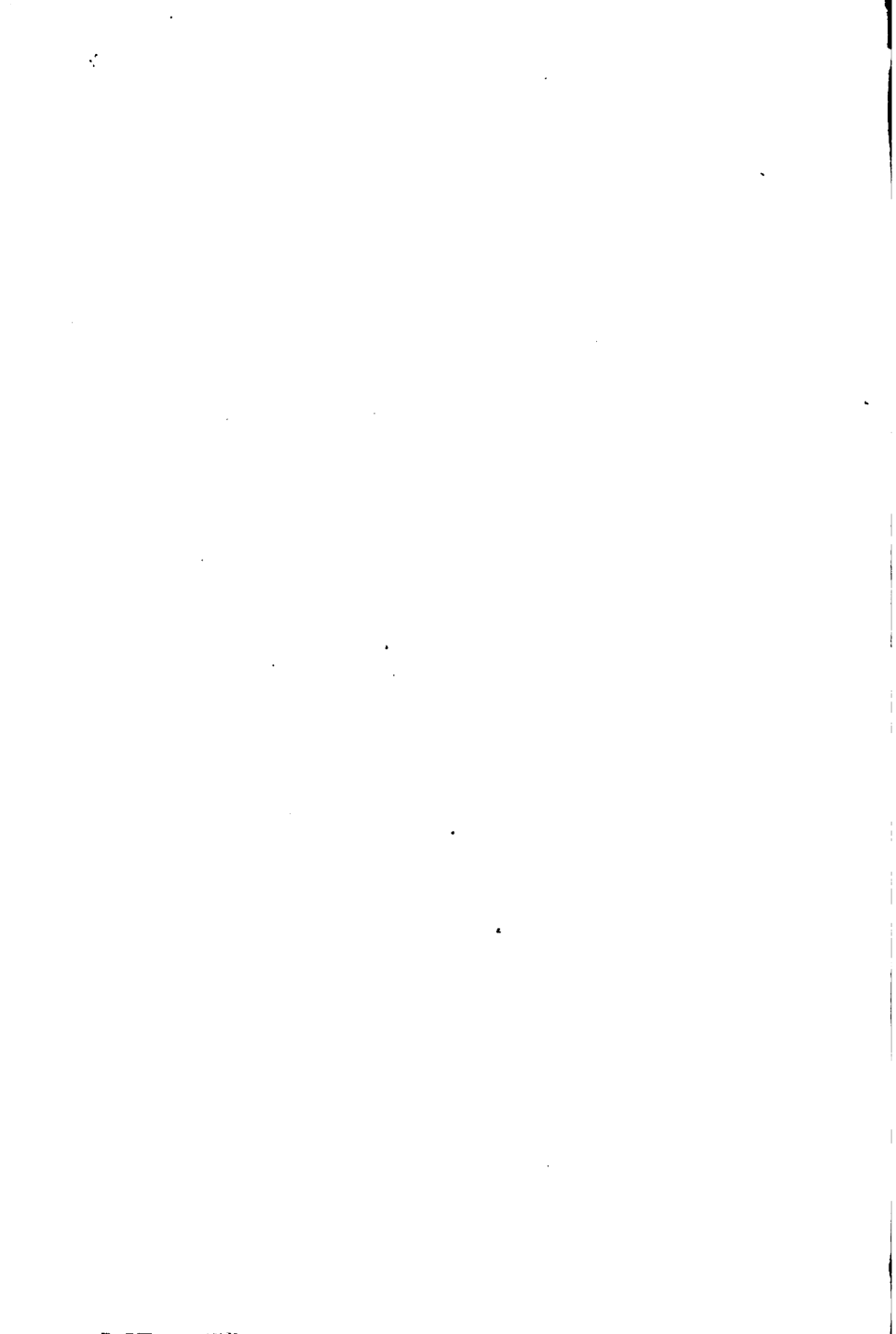
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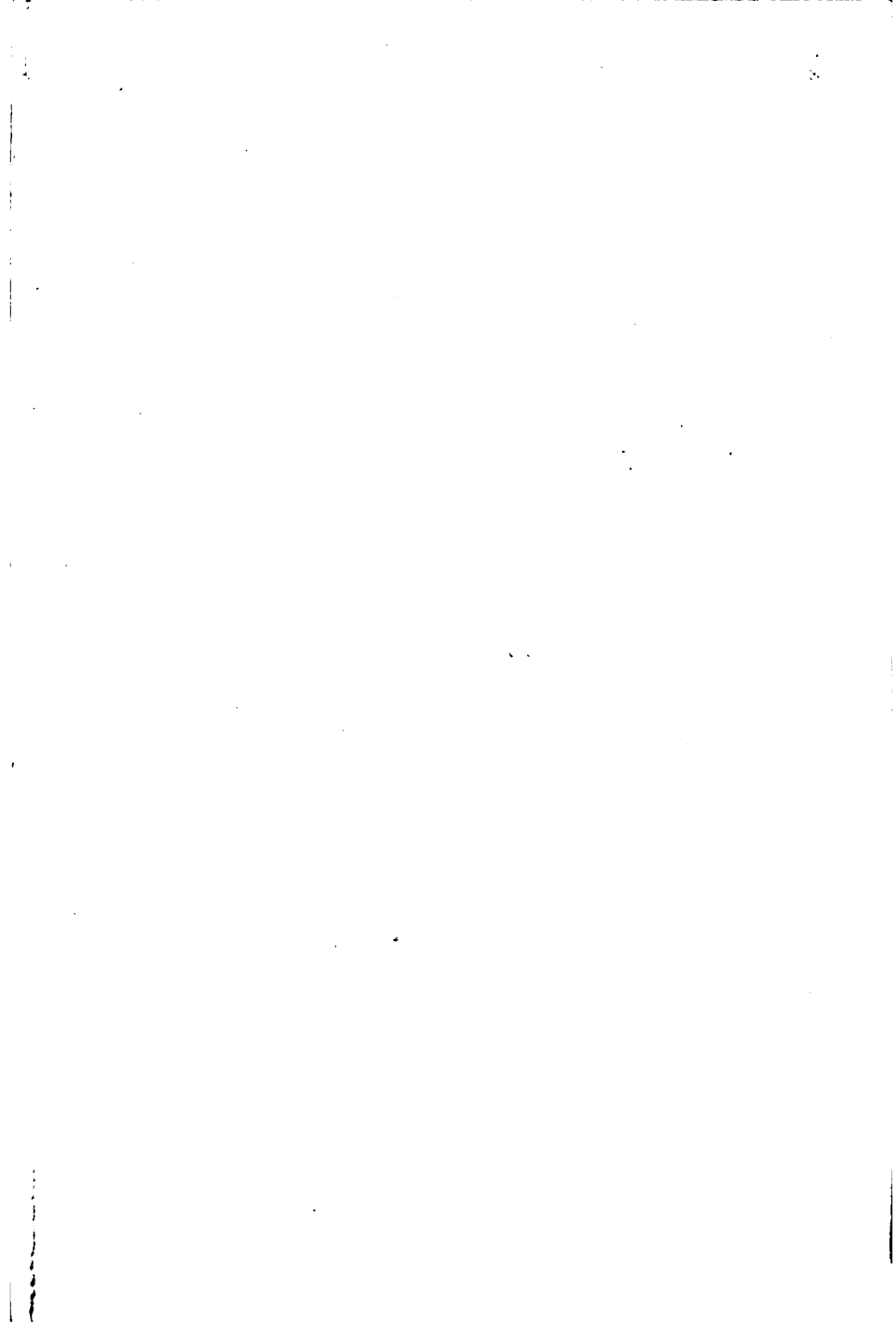
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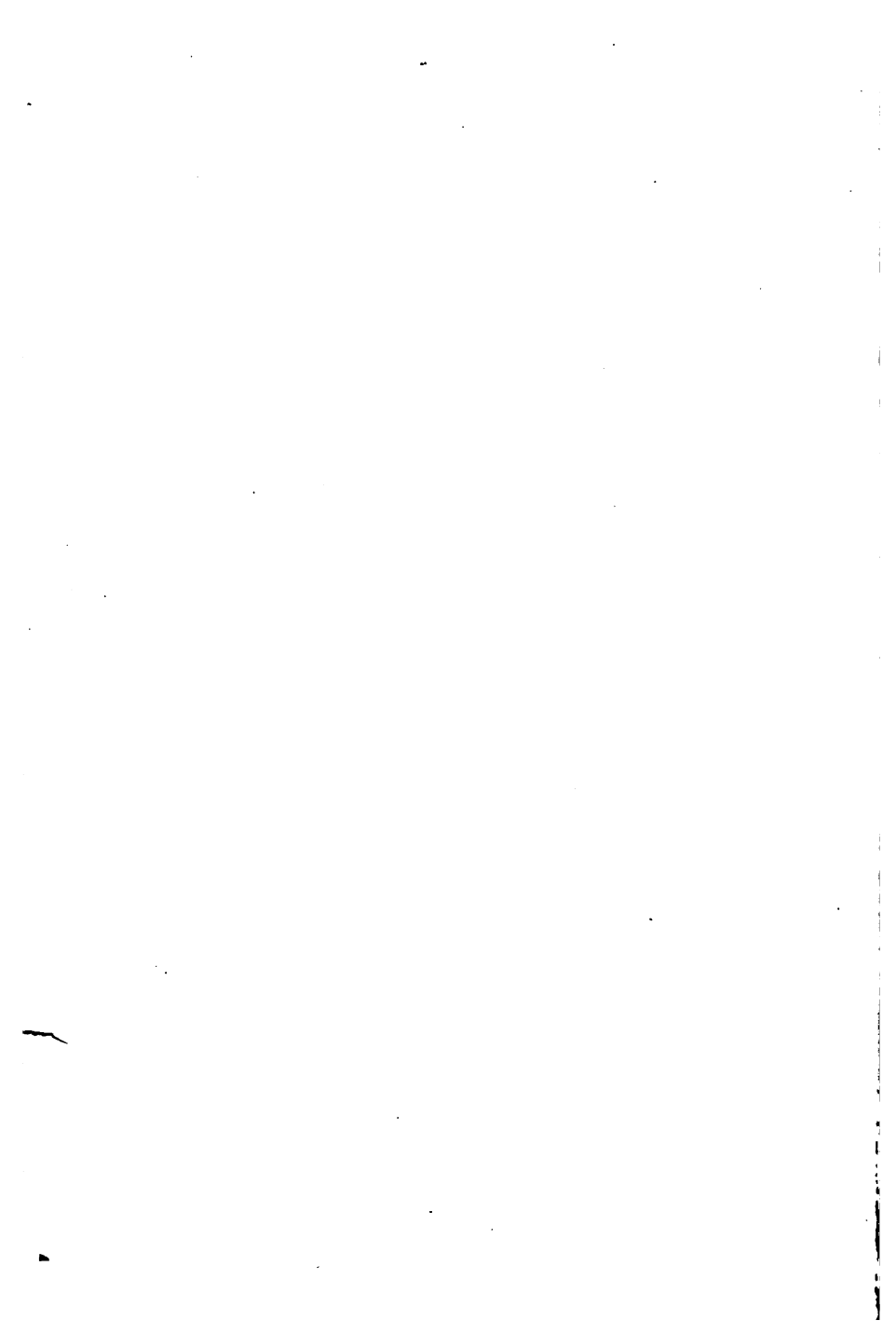


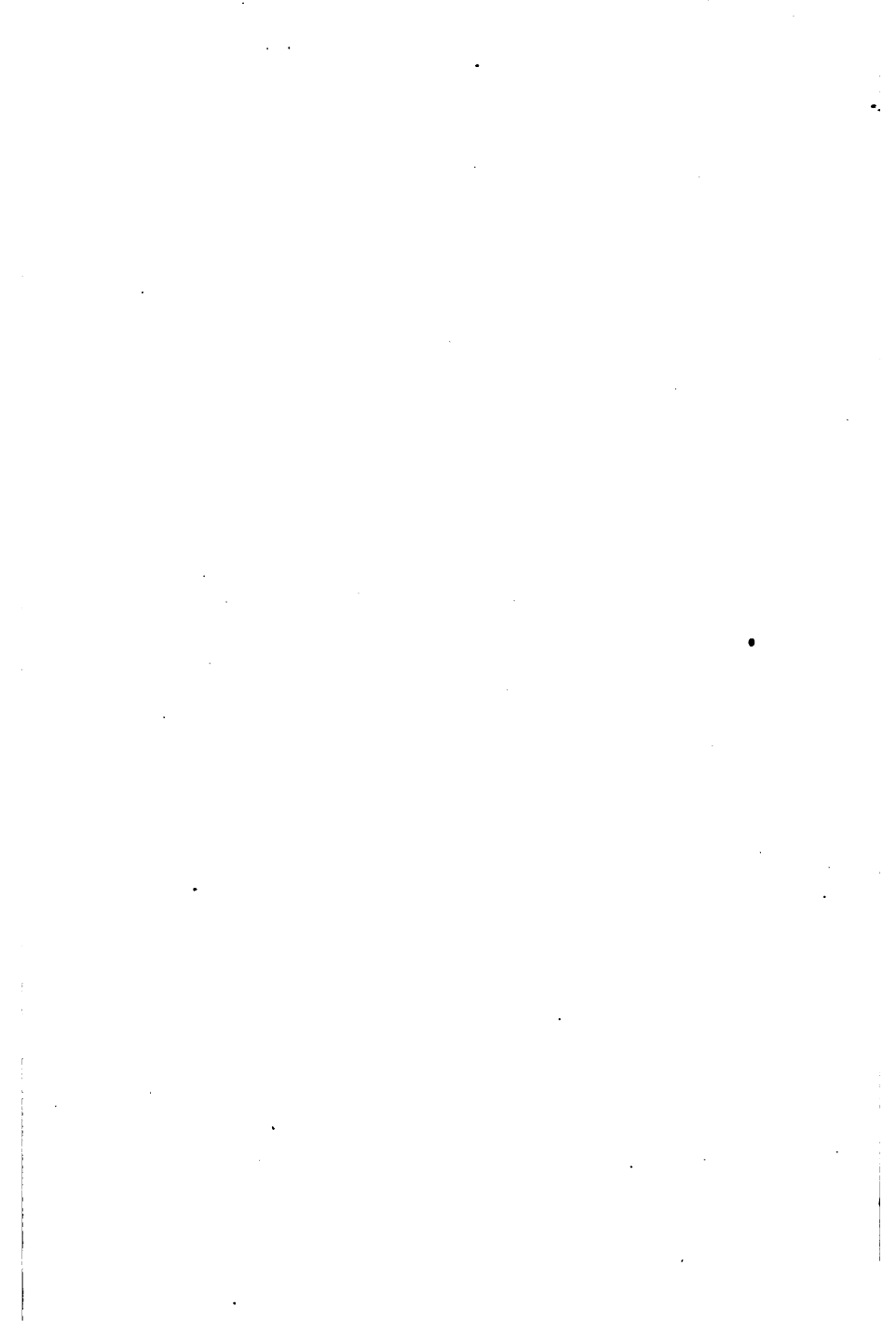












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